University of Johannesburg

Faculty of Education

Mentoring for mathematics teaching in the foundation phase: The views of students and their mentors

Mosa Nontsikelelo Khasu

201131109

Dissertation submitted for the degree

Masters in Education

in

Childhood Education

at the

University of Johannesburg

Supervisor: Mrs Kathleen Fonseca

Co-supervisor: Professor Nadine Petersen

Date: February 2019

DECLARATION

I declare that this is my original research for the purpose of this dissertation, Student teachers and their mentors’ views of the processes of mentoring for mathematics teaching in the foundation phase.

……………………………………………………

Mosa Nontsikelelo Khasu

14 February 2019

DEDICATION

This study is dedicated to my late grandmother, Anna Masabata Khasu.

It is also dedicated to my mother Khopotso Khasu.

ACKNOWLEDGEMENTS

I would like to acknowledge the following individuals who have contributed to the completion of this dissertation:

Firstly, I want to thank the almighty God for giving me the strength to never give up in completing this dissertation. I am thankful Lord for all leading and guiding my footsteps.

To my research supervisors, Professor Nadine Petersen and Mrs. Kathleen Fonseca. I want to express a heartfelt thank you for the contributions you made to this dissertation. I have learnt so much from the both of you as my mentors and I am thankful for your guidance and insights.

To all the teachers and student teachers who participated in this study, I am truly grateful for your contributions.

To my husband, Bongani Msimango. I want to thank you for the support you have given throughout this entire process. Thank you for always supporting my aspirations.

To my mother, Khopotso Khasu. I want to thank you for igniting the passion for education in me. Thank you for being an amazing teacher and a source of inspiration.

Finally, I want to thank my family and friends for all the love and support throughout this journey.

ABSTRACT

The aim of this study is to report on student teachers and their mentor teachers' views on the processes of mentoring. Schoenfeld's (2016) TRU Maths Framework provides an over-arching lens for examining teachers mentoring practices in guiding student teachers to develop and enhance their mathematics PCK. Data was collected using interviews for the three mentor teachers and two focus group interviews for the twelve student teachers at a university-affiliated teaching school in Johannesburg. My experience as a mentor teacher at the teaching school motivated me to conduct this study because I observed that student teachers generally have trouble in teaching mathematics in the foundation phase.

Based on TRU Maths Framework, I analysed the data obtained from the individual interviews with the mentor teachers and the focus group interviews from the student teachers. The data was analysed using the *Constant Comparative Method* (Glasser & Strauss, 1967). The main finding was that the newness of the teaching school, the practicum and mentor teachers experiences led to a procedural form of mentoring with minimal developments of student teacher's development of a robust understanding of mathematics teaching. Student teachers reported that they do not all get the opportunity to form meaningful mentor-mentee relationships with their mentor teachers at the school because of the large number students in each practicum group. In addition, student teachers and their mentor teachers recognised the importance of mathematics content knowledge as a pre-requisite for effective mathematics teaching. I concluded that the mentor-mentee relationship is important for improving the mentoring practices of mentor teachers. Good mentoring practices can assist student teachers in developing and improving their mathematics PCK and their overall professional development (Hudson, 2013).

TABLE OF CONTENTS

DECLARATION i

DEDICATION ii

ACKNOWLEDGEMENTS iii

ABSTRACT iv

TABLE OF CONTENTS v

LIST OF TABLES x

LIST OF FIGURES xi

CHAPTER 1: OVERVIEW AND BACKGROUND 1

1.1 Introduction 1

1.2 Background 2

1.2.1 Problems arising from the practicum experience in student teacher education 2

1.2.2 Closing the practice-theory gap in teacher education using a ‘teaching school’ model 4

1.3 Problem Statement 8

1.4 Research question 9

1.4.1 Sub questions 9

1.5 Aim of the study 10

1.6 Research objectives 10

1.7 Study of the literature 10

1.7.1 Evaluation and feedback on lesson presentations 10

1.7.2 Reflection on mathematical processes when teaching 12

1.8 Research Methodology 13

1.9 Research Design 13

1.10 Sampling 14

1.11 Data Collection Methods 14

1.12 Data Analysis 15
1.13 Research ethics 15
1.14 The structure of the dissertation 16
1.15 Conclusion 16
CHAPTER 2: LITERATURE REVIEW 17
2.1 Introduction 17
2.2 The transition from traditional apprenticeship to cognitive apprenticeship 17
2.3 Theoretical framework 22
2.4 South Africa's poor history of mathematics teaching 24
2.5 The problem of poor mathematics content knowledge of student teachers 31
2.6 What can be learned from ITE research? 36
2.7 Research on first year student teachers' MCK and its impact on developing PCK 40
2.8 Mentoring student teachers 43
2.9 Mentoring for the development of pedagogical skills for mathematics 47
2.10 Reflective practice for developing mathematics pedagogical content knowledge (PCK) 50
2.11 Conclusion 52
CHAPTER 3: RESEARCH DESIGN & METHODOLOGY 53
3.1 Introduction 53
3.2 Positioning myself as a researcher in an educational setting 53
3.3 Designing a study to investigate the mentoring of mathematics in the foundation phase 56
3.4 Data collection methods 57
3.5 Sampling: purposely choosing participants 58
3.6 Interviews as data collection method-focus and individual interviews 59
3.7 Conducting a pilot: learning from my mistakes 59
3.8 Data analysis methods 60

3.9 Validity and reliability 61
3.10 Ethical considerations 62
3.11 Conclusion 64
CHAPTER 4: THE ANALYSIS OF DATA 65
4.1 Introduction 65
4.2 Using the constant comparative method of data analysis 65
4.3 Interview schedule and demographics: mentor teachers 66
4.3.1 Interview questions for mentor teachers 67
4.3.2 Interview schedule and demographics: student teachers 68
4.3.3 Focus group interview questions 68
4.4 Preparing the data for analysis 69
4.5 Coding the data to source – labelling the data sets for analysis 69
4.5.1 The initial discovery process 69
4.5.2 Discovery Sheet 70
4.6 Coding the data – making sense of the meaning of interviews 70
4.7 Using the 'look/feel-alike' method to create provisional categories 72
4.7.1 Provisional category 1: The value of exposure to different mentor teachers during the practicum 73
4.7.2 Provisional category 2: Mentoring practices influence students learning 73
4.7.3 Provisional category 3: The importance of mathematics content knowledge 74
4.7.4 Provisional category 4: Interactive teaching methods learned from mentor teachers 75
4.7.5 Provisional category 5: The value of being aware of different learning styles 75
4.7.6 Provisional category 6: The importance of teaching aids 76
4.7.7 Provisional category 7: Developing reflective practice 77
4.7.8 Provisional category 8: The teaching school as a mentoring laboratory and student teachers impressions of mentoring 78

4.7.9 Provisional category 9: Linking coursework with practice in the practicum 79

4.8 Participants' responses, which do not fit with mentoring and mathematics teaching ... 80

4.9 Provisional categories to categories ... 80

4.10 Step 2: Creating categories ... 81

4.11 Step 3: Exploring relationships and pattern across categories ... 85

4.12 Themes emerging from the categories ... 89

4.12.1 Overarching finding ... 90

4.12.2 Student teacher and mentor teachers recognise the importance of mathematical content knowledge as a pre-requisite for teaching mathematics and for optimal mentoring to occur. ... 90

4.12.3 Mentor teachers and student teachers experiences of the mentor-mentee relationship. ... 90

4.12.4 There is value to student teachers having different mentor teachers over the course of their studies. ... 91

4.13 Conclusion ... 91

CHAPTER 5: FINDINGS & DISCUSSION ... 92

5.1 Introduction ... 92

5.2 Recognising the importance of mathematics content knowledge in teaching ... 92

5.2.1 Making connections with what learners already know ... 94

5.2.2 Planning for teaching ... 95

5.2.3 The absence of theoretical knowledge in the lesson plans ... 97

5.2.4 Student teachers understanding of the curriculum and mathematics content knowledge ... 98

5.2.5 Teaching aids for enhancing mathematical content knowledge ... 100

5.3 Mentor teachers and student teachers experiences of the mentor-mentee relationship ... 101

5.3.1 Student teacher's experiences regarding the mentor-mentee relationship 103

5.3.2 Difficulties experienced by mentor teachers and student teachers regarding the practicum 104

5.3.3 Mentors using a systematic process of guiding students 108

5.4 There is value to student teachers having different mentor teachers over the course of their studies 112

5.4.1 Teaching methods observed by student teachers during the practicum 113

5.4.2 Student teachers impressions of their teaching school and WIL mentor teachers 117

5.5 Conclusion..120

5.6 Limitations 121

5.7 Recommendations...122

REFERENCES...123

ADDENDUM 1: Ethics Clearance Certificate...130

ADDENDUM 2: Interview transcripts...131

ADDENDUM 3: Interview codes..144

LIST OF TABLES

Table 2.4.1 South Africa's performance in TIMSS assessments (Reddy et al, 2006)....27
Table 2.4.2 ANA mathematics results from 2012 – 2014 (DBE ANA Report, 2014)....28
Table 2.4.3 SAQMEQ mathematics results for South African grade 6 learners (Portfolio Committee on Basic Education, 2016)....30
Table 2.5.1 Curriculum outline for Mathematics and Mathematical Literacy in the CAPS document (2011) 33
Table 2.6.1 Basic information about the mathematics offering for prospective IP teachers not specializing in mathematics (Bowie, 2014) 37
Table 2.6.2 Number of contact hours spent of mathematics content and methodology courses in a four-year B Ed course 39
Table 4.3.1 Mentor teacher's demographics....67
Table 4.3.1.1 Details of the interviews with the mentors....67
Table 4.3.2.1 Demographics of student teachers 68
Table 4.6.1 Focus Group 1: allocated codes for units of meaning 71
Table 4.6.2 Example of units of meaning (interview codes)....72
Table 4.9.1 Provisional categories derived from units of meaning....81
Table 4.11.1 Categories derived from provisional categories 86
Table 5.3.3.1.1 Post-lesson mentoring questions for student teachers 110

LIST OF FIGURES

Figure 1.11.1 Data collection time-line for the study 15
Figure 2.2.1 Principles of traditional apprenticeship (Collins et al, 1991:39) 18
Figure 2.2.2 Principles for designing cognitive apprenticeship environments (Collins et al, 1991) 20
Figure 4.2.1 The Constant Comparative Method for data analysis (Glaser & Strauss, 1967) 66
Figure 4.7.1.1 Mind map 73
Figure 4.7.2.1 Mind map 2 74
Figure 4.7.3.1 Mind map 3 74
Figure 4.7.4.1 Mind map 4 75
Figure 4.7.5.1 Mind map 5 76
Figure 4.7.6.1 Mind map 6 77
Figure 4.7.7.1 Mind map 7 78
Figure 4.7.8.1 Mind map 8 79
Figure 4.7.9.1 Mind map 9 79
Figure 4.10.1 Synthesizing the data to create categories 82
Figure 4.10.2 Creating category 1: Teachers follow a systematic process of guiding student teachers 82
Figure 4.10.3 Creating category 2: The value of student teachers having different mentor teachers 83
Figure 4.10.4.4 Creating category 3: The importance of teaching aids to develop student teachers' teaching methods 84
Figure 4.10.5 Creating category 4: The importance of mathematics content knowledge for accommodating different learning styles 85
Figure 4.11.1 Exploring relationships between category 1 and 2 86
Figure 4.11.2 Exploring relationships between categories 3 and 4 87
Figure 4.11.3 The relationship between category 2 and 4 88
Figure 4.11.4 The relationship between category 1 and 3 89
Figure 5.4.1.1 Common teaching methods observed by third year students and used by the mentor teachers at the teaching school 113

CHAPTER 1:
OVERVIEW AND BACKGROUND

1.1 Introduction

Teacher training institutions are crucial in the training and development of incoming teachers in the profession (Hudson, 2007). Initial teacher education programmes have been criticized in the past for producing teachers who are unable to meet the demands of the curriculum or adequately teach the content in the curriculum (Crowther & Cannon, 1998; Hudson, 2013). This is more evident in the training of mathematics teachers. Foundation phase mathematics programmes need to adequately develop student teachers to teach mathematics for robust understanding (Schoenfeld, 2016). South African study by Fonseca and Petersen (2015), they found that student teachers enter into initial teacher education programmes with poor mathematics content knowledge.

This is problematic because it suggests that the quality of the intake of B Ed students in many universities is contributing to the poor pedagogical content knowledge of many teachers. In this study, I unpack the mentor teachers and student teachers views of the processes of mentoring for mathematics teaching in the foundation phase. In my argument, I discuss the relevance of the seminal work of Collins, Brown and Holum (1991) on *cognitive apprenticeship*, which is about how mentor teachers make their thinking explicit for student teachers during the process of mentoring. I argue how this model can contribute to improved teaching of mathematics concepts in the foundation phase. Furthermore, I focus on the mentor teachers' role in assisting student teachers link theory with practice (Hudson, 2007). Initial teacher education programmes benefit and enhance the student teachers' learning if student teachers can adequately learn to link theory with practice. More importantly for university-affiliated schools, which is the context for this study. Within this practicum model, student teachers should be mentored extensively to help them link theory with practice (Gravett & Ramsaroop, 2017). It is also expected that the nature of the teaching school as a 'laboratory school' that best practices would be modelled for student teachers (Gravett, Petersen & Petker, 2014).

1.2 Background

Questions have been raised about the ability of teacher education programmes to adequately prepare student teachers for the world of work and in particular teaching 21st century skills to a diverse population of learners (Darling-Hammond, 2006). Teacher education programmes have long been criticized for being too theoretical at the expense of developing practical learning (Darling-Hammond, 2006, Korthagen, 2004). Student teachers too often feel that they learn more about practical teaching knowledge once they are employed at schools than they do at university (Gravett & Ramsaroop, 2015). Although John Dewey has noted the relationship between theory and practice in teacher education as early as 1904, it remains a problem for current teacher education (Lanier & Little, 1986). Within teacher education, practice teaching, also referred to as work integrated learning (WIL) or practicum (here referring to practical learning in school teaching contexts) is deemed to provide prospective teachers with opportunities to integrate theoretical knowledge with practical knowledge (Allen & Wright, 2014). However, this component in teacher education is not smooth sailing. Student teachers come across problems such as the learners' socio-economic backgrounds and a lack of resources. Furthermore, many student teachers find it difficult to link the theory or coursework from their studies with the practice they engage in during their WIL (Danielson, 2002).

1.2.1 Problems arising from the practicum experience in student teacher education

One of the foremost writers in initial teacher education, Darling-Hammond (2006), suggests that the practicum is one of the most effective ways of supporting prospective teachers' learning, if the coursework is carefully linked to classroom practices. Novice teachers thus need to see the link between theory and practice, while engaged in school experience. Darling-Hammond (2006) further identified a number of ways in which theory and practice can be linked in the practicum. These include a strong school-university partnership and a well-designed work integrated learning (WIL) programme, which links theory and practice. Thus, even though the practicum is foregrounded as one of the answers to addressing the theory-practice gap in teacher education, there are constraints associated with the practicum. These constraints influence negatively on the effectiveness of learning during WIL. It furthermore points to the importance of effective school-university partnerships in order to help ensure the integration of theory and practice.

An effective practicum is prefaced on the notion of a partnership between two entities: university-based teacher educators and school-based teachers. Research about school-university partnerships point to a lack in communication between school staff and university staff, which result in uncertainty among stakeholders about what is being expected from them (Allen & Peach, 2007). There is, however, insufficient empirical research about the experiences and perceptions of student teachers and their ability to bridge theory and practice as they transition into the workplace (Korthagen, Loughran & Russel, 2006; Petersen, 2017).

The practicum experience is rife with many tensions. Some of these stem from student teachers' uncertainties about what to do in another teachers' classroom. This may be due to a lack of effective communication between the teacher and the student teachers. In a study by Gravett and Ramsaroop (2017), the authors highlight that ineffective mentoring programmes within a teaching school may result in student teachers not learning from best practice. Resultantly, they might very well remain ill equipped for effective teaching once they enter the workplace. This implies that effective mentoring programmes are essential to ensure that teachers play a more effective role in helping student teachers. During WIL sessions, mentor teachers must ensure that student teachers link relevant theoretical aspects from their coursework with teaching practice in real classroom settings.

Danielson (2002) describes mentoring as the process that enables the novice teacher to teach in accordance with professional standards. It is a process, which requires the mentor teacher to be aware of the evolving needs of the novice teacher. Often good teachers are assumed to be good mentor teachers. However, the process of mentoring requires a certain level of preparation to enable the professional development of novice teachers (Danielson, 2002). This means that mentoring sessions should be planned and focused towards professional development of novice teachers and not only evaluating lessons. Mentor teachers should thus be well trained in mentoring and be the kind of role model that will assist prospective teachers in linking theory with classroom-based teaching practices (Gravett & Ramsaroop, 2017). Good mentoring is not dependent on the teacher's ability to teach well, but rather how to mentor within a specific field.

The process of mentoring novice prospective teachers demands that a mentor teacher be able to integrate their content and pedagogical knowledge for teaching learners and be able to demonstrate to student teachers what an effective teaching episode entails (Danielson, 2002). Mentor teachers at the teaching school are required to model best teaching practices and provide student teachers with guidelines for teaching concepts in a manner that promotes conceptual understanding of concepts.

1.2.2 Closing the practice-theory gap in teacher education using a 'teaching school' model

The issue of creating powerful and effective practices to bridge theory and practice in the practicum is a well-noted concern, also in South Africa. In 2009, the Teacher Development Summit was held by the Education Labor Relations Council (ELRC) to discuss challenges related to the training of teachers by teacher education providers. Student teachers across the country are placed in schools as part of their work-integrated learning (WIL). This forms part of the school experience and practical training components of teacher education. This requires universities to establish relationships with schools, in order to accommodate their students for practicum sessions (Reddy, Menkveld & Bitzer, 2008).

The practicum has always been an important aspect of teacher education programmes. Arrangements and its implementation vary across different teacher training institutions (Vick, 2006). Generally, the practicum is considered an ideal opportunity for students to integrate their theoretical knowledge with classroom-based practice. This is deemed a necessary step in ensuring readiness for the workplace. However, in practice the value of WIL is often far less valuable than its intended purpose. In some cases, it may simply have become a process of placing a tick on a checklist given the stark realities of school-based education in South Africa (Reddy et al, 2008). Furthermore, after the work of Edwards and Protheroe (2004), argue that mentor teachers in primary schools are merely doing what they think is required of them. In practice, this often means that they are handing over their classes to student teachers, observing lessons and giving oral and written feedback. There is clearly inadequate and a far cry from what mentoring is meant to be. Inadequate mentoring results in a lack of transference of skills between the teacher as mentor and the student teacher as mentee. Viewed in terms of the knowledge domains along the Mathematical

Knowledge for Teaching framework, (Ball, Thames & Phelps, 2008) it means that student teachers do not learn best practice during their WIL practice sessions.

This has raised a considerable amount of concern about the quality of teacher education and the value that student teachers derive from their WIL practice sessions. When student teachers are not mentored well. During the practicum their learning becomes incidental, leaving student teachers with the task of linking their coursework to classroom-based practices. Given they need to increase the quality of teachers and education in South Africa, one has to question they type of experiences students are exposed to during their WIL. Above all, given the amount of time, effort and monetary resources associated with teacher education generally and WIL in particular, ensuring effective mentoring takes place becomes essential. However, as explored in this study, effective mentoring and best practice go beyond a single classroom, but requires a well-managed, controlled environment – one in which all facets of the school are geared towards excellence. A school that has a close relationship with a university offers such an environment.

Zeichner (1999) argued that it is not about the quantity or prolonged experiences in schools, but rather the quality of the prospective teachers' learning experiences during their practicums in schools. South Africa's Department of Basic Education & Higher Education and Training in 2011, established The Integrated Strategic Planning Framework for Teacher Education and Development in South Africa partially to address this issue. The framework is aimed at improving teaching practice/school experience through the development of teaching schools and Professional Schools (The Department of Basic Education & Higher Education and Training, 2011). It is within this context that this study is located.

In 2010, a Faculty of Education at Johannesburg-based university established a teaching school at one of its campuses through a memorandum of agreement (MOA) with the department of Higher Education and the Gauteng Department of Education (GDE). The establishment of the school had several aims, one of which was to strengthen primary school teacher education. In this model of teacher education, student teachers are placed in a teaching school for the duration of their programme (four years); the expectation is that school teachers will provide mentoring and teach student teachers about professional practice. The fundamental difference between a teaching school and an ordinary mainstream school is that students would be mentored through effective and structured mentoring programmes (Gravett & Ramsaroop, 2015). Teaching schools are also described as 'teaching laboratories' (Gravett, Petersen & Petker, 2014) where student teachers can learn by engaging in and observing best practice from mentor teachers.

Gravett and Ramsaroop (2015) argue that mentor teachers at teaching schools have the responsibility to identify, demonstrate and share best practice with student teachers. This can also imply that teachers in a teaching school serve as models for the student teachers. Thus, teachers at teaching schools should teach student teachers about good teaching practice and help instill the necessary skills for effective classroom-based practices. Above all, the process of mentoring entails the establishment of a relationship between two parties, i.e. a mentor and mentee. As highlighted in this study. The relationship between a teaching school and the university – as governed by the MOA – enables the relationship between mentor teachers and student teachers. Various mechanisms are put in place to help ensure an effective School-University Partnership involving the teaching school and the university. Like with all partnerships, effective communication remains of paramount importance. This is to ensure that all the stakeholders have a clear definition of their respective roles and responsibilities (Allen & Peach, 2007). Integrated into a teacher-training programme such as the one that operates at the institution where this study was conducted the role of in-service teachers are well defined in a mentoring programme that is underpinned by a particular theoretical premise.

According to Leindhart's (1993) theory, the mental structures in skilled or expert teachers differ from that of novice teachers. This theory supports the process of mentoring that needs to occur in order for the student teachers to become expert teachers through the guidance of their mentor teachers. This framework is primarily concerned with comparing the Pedagogical Content Knowledge (PCK) of an expert teacher with that of a novice teacher. This theory is derived from Shulman's (1987) theory of knowledge domains. The domains include knowledge of the curriculum, knowledge of the learners, content knowledge, pedagogical knowledge and knowledge about educational aims. The domains of PCK offers a useful framework to identify specific areas of best practice and can be measured (Shulman, 1987). The mentor teacher needs to embody these knowledge domains and demonstrate to student teachers how to effectively integrate these in the process of teaching and learning, with both the content and practices are adapted for specific subject areas, such as mathematics. Therefore, PCK in the mentoring process will be specific to mathematics, for example, when involving student teachers.

In preparing students to teach mathematics, mentors need to direct student teachers to consult the Curriculum Assessment Policy Statement (2011) (CAPS) in order to know what concepts to teach. Then student teachers need guidance on the required PCK for teaching these concepts. At this stage, the role of the mentor teacher becomes critical to show the mentee (student teacher) how to develop effective PCK from content knowledge (CK) and pedagogical knowledge (PK). Developing effective PCK for mathematics teaching relies upon how best the student teachers interpret the policy document; an ability to identify the mathematical processes that need to be taught is therefore just part of the process. The other part involves an ability to decide how best to teach the concepts – in other words, a decision about the most effective PCK.

Apart from the mentor teacher's own PCK as a contributing factor to the success of mentoring, another factor affecting the success of the mentoring process relates to the mentor teacher's own knowledge about mentoring per se. In those instances where mentor teachers' own abilities to mentor are limited to the notion of showing mentees how to teach, the overall richness we associated with mentoring can be lost. This could suggest that student teacher's needs for holistic development are not being met (Kuzler & Beihler, 2014). Mentor teachers themselves require continuous mentoring training. Within a teaching school environment, mentor teachers should thus be well-equipped for the mentoring process. Given historical difficulties with certain subject areas such as mathematics, the notion of well-equipped mentor teachers become more pronounced.

Kuzler and Beihler (2014) argue that mathematics mentor teachers need to be capacitated in mentoring programs to ensure that they can mentor student teachers on how to teach. The authors argue that good mathematics teachers may not necessarily be good mentor teachers. Good teaching practices by the mentor teacher still needs to be modelled to the student teacher through the process of mentoring. The student teacher's methods of teaching may then be reflective of good practice modelled by the teacher. This may not necessarily be because of good mentoring, even though modelling good practice forms part of good mentoring. This means that mentor teachers need to do more than just to model good practice (Edwards & Protheroe, 2004). Their practice should be informed by theory and should be made explicit to novice teachers about why the teaching episodes unfold in a particular manner. There needs to be accountability in teaching in order to explain the practice to young student teachers.

Encapsulated in a well-planned teacher-training programme in which a functional school-university partnership ensures effective integration of the teaching school, mentor teachers are key to student teachers' practicum experience. As a former mentor teacher in the foundation phase, I am aware of the importance of the role of a mentor teacher in any classroom environment. In this role, I am of the view that mentor teachers must provide enriching experiences to student teachers. After all, mentor teachers are part of their journey in becoming excellent teachers. However, I have observed that not enough attention is given to mentoring along subject specific requirements, which suggests that mentoring is not structured enough. Instead, it is often dependent on each teacher's own experiences, specifically in mentoring student teachers to teach mathematics. Furthermore, in guiding prospective teachers in the planning of mathematics lessons, mentor teachers usually focus on 'the what' to teach and neglect 'the how' to teach. The 'how to' teach is important in promoting an understanding for mathematical processes principles governing problem solving, proving, conjecturing and justifying (Schoenfeld & Floden, 2014). These processes are fundamental for developing both procedural and conceptual knowledge about mathematics. Another reason why mentor teachers do not emphasize mathematical processes during their lesson planning and lesson presentations might relate to their own lack of content knowledge (CK), pedagogical knowledge (PK) as well as pedagogical content knowledge (PCK). This results in a lack of confidence when teaching mathematics concepts (Danielson, 2002), which manifests in limited self-efficacy. They are not sure of how to teach certain concepts because they lack adequate PCK. This has lead me to question the efficacy of the current teaching practices student teachers are exposed to and how this impacts on the mentoring practices in mathematics foundation phase classrooms in the teaching school.

1.3 Problem Statement

The newness of a teaching school raises concerns about mentor teachers not being adequately trained in mentoring student teachers. The university has the responsibility to ensure that mentor teachers are well trained. If this is not the case then teachers are merely going about the business of teaching and placing the responsibility on student teachers to learn through observations where they are likely to replicate the teaching methods they are exposed to. There is a consistent intentional process to guide and scaffold student teachers, in making sense of what they see in the classroom. This leads to student teachers not fully understanding their role in supporting the learners in the classroom. The lack of training about mentoring for mentor teachers is an injustice for student teachers because they cannot be expected to learn how to link effectively the theory with practice, if the mentoring is inadequate. Problems in this sphere often results in student teachers not being aware of the role of the practicum and difficulty in linking theory with practice. The development of mathematical thinking processes in mathematics teaching is fundamental to learners developing conceptual understanding of mathematical concepts. Student teachers will thus improve their mathematical PCK and mentor teachers assist in bridging the gap between theory and practice. Given what I have observed at the teaching school I was interested in understanding the process of mentoring from the perspective of both teachers and student teachers in the foundation phase. In light, hereof the following questions were set:

1.4 Research question

What are student teacher's and their mentors' views of the process of mentoring for mathematics teaching in the foundation phase?

1.4.1 Sub questions

The sub-questions were detailed as follows:

i) How do student teachers reflect on the mentoring process for the teaching of mathematics for the foundation phase?

ii) How do mentor teachers reflect on the mentoring process for the teaching of mathematics in the foundation phase?

iii) What is the extent and nature of student teachers' developing PCK for mathematics?

1.5 Aim of the study

The aim of this study is to report on student teachers and mentor teachers views on the processes of mentoring. In addition, to examine what contributes to successful mentoring in foundation phase mathematics classrooms.

1.6 Research objectives

The objectives of this study are to understand student teacher's and their mentor teacher's perceptions about mentoring for mathematics teaching:

• Unpack the mentor teachers' mentoring practices for enhancing student teachers' development of mathematical PCK.

• Identifying steps and approaches that mentor teachers use when they engage with student teachers during lesson planning.

• Investigate how student teachers integrate the advice and practices learnt from their mentor teachers during lesson planning and lesson presentations.

1.7 Study of the literature

Generic qualitative studies are informed by existing theories. I discuss the theoretical premises upon which this study is based. The lack of structured mentoring does not enhance student teacher's ability to teach mathematical processes to children; neither does it enable them to incorporate it in the lesson planning (Danielson, 2002). Schoenfeld's (2016) framework on Teaching for Robust Understanding (TRU Maths) can provide a theoretical lens for developing structured mathematics mentoring sessions with student teachers, to assist them in teaching mathematical concepts more effectively. This framework focuses on conceptual ideas which should be incorporated in the teacher's PCK to ensure learners develop a deeper understanding of mathematical concepts they are being taught.

1.7.1 Evaluation and feedback on lesson presentations

Prospective teachers are continuously evaluated at the teaching school and receive feedback on their lesson planning and presentations. This practice is common in teaching practicums also those at mainstream schools, where student teachers are evaluated based on their lesson presentation (Danielson, 2002). However, within the teaching context of the teaching school, student teachers plan one lesson presentation per cycle as a group; only one student teacher from the group presents the lesson. With only four cycles in a year, this means that only four student teachers from a group will present one lesson each for that particular year. In my view, this is surely not the ideal way to give individualized feedback to novice teachers. The feedback is mainly a critique of the group's effort in as far as it pertains to the planning and preparation of the lesson.

As a mentor teacher, it is important to ensure that the group takes responsibility for the outcome of the lesson because the student teacher presenting the lesson is considered to be a reflection on the entire group's effort because they plan lessons in groups.

Mentor teachers have the responsibility to ensure that student teachers can ultimately learn from their experience. Feedback on lesson presentations is aimed to get students teachers to reflect on what worked and what did not work – an effort to work towards best practice for PCK developing. Best practice become embedded once student teachers start to exhibit an ability to apply the feedback they received as a group in their own individual teaching practices when they go to mainstream schools for their Work-Integrated Learning (WIL); this ability provides proof of their development. In essence, this means that student teachers are required to apply what they learn in a controlled environment like the teaching school in real-life working environments that are often less than ideal (Reddy et al, 2008).

Teaching mathematics requires student teachers to have extensive understanding of mathematical processes to ensure that they can teach for conceptual understanding. Success when performing mathematical processes require deepened understanding of concepts and principles, which depend on effective teaching methods. These are often referred to as 'skills' that learners need to be able to demonstrate, if they are to show their understanding of a particular concept. The CAPS (2011) policy document highlights these skills, which the teacher is required to instill when teaching mathematical concepts. These skills include the ability to question, reasoning, justification and problem solving. Improved mathematical proficiency among learners is thus reliant upon effective teaching and a teachers' ability to ensure that concepts and principles are well understood (Schoenfeld, 1985). Teachers need to know how to assess these skills because they form part of assessing student teachers mathematical PCK.

1.7.2 Reflection on mathematical processes when teaching

Jones and Ryan (2014) argue that highly reflective practices can help bridge the gap between theory and practice. The idea of reflective practice in teaching has become a fundamental idea in striving to develop good teachers. Authors such as Brookfield (1995), Korthagen (2001) and Schon (1983) also poses similar arguments. Schon's (1993) model emphasizes reflection for action, reflection in action and reflection on action. In fact, it is the basis of the model used at the teaching school. It is also applied in a technical manner to provide feedback on student teacher's lesson presentations. This means that it is prompting mentor teachers to get student teachers to think critically about what they are teaching and why they are teaching in a particular manner.

My one critique of Schon's (1983) model is that it does not allow for sufficient critical reflection. In addressing what I view as a shortcoming in Schon's model of reflection, I turn instead to Kreber and Cranton's (2000) model of transformational learning. This model identifies three aspects of reflection, namely content reflection, process reflection and premise reflection. Content reflection is about describing the problem and problematic teaching strategies that were used. This approach allows student teachers to interrogate the problem by identifying the cause of the problems during their teaching. The second aspect is process reflection. This type of reflection seeks to uncover the theoretical underpinnings of their actions. This compels student teachers to think about what theories inform their teaching strategies, in particular their pedagogical knowledge when teaching a particular concept. Lastly, the third aspect refers to premise reflection. This type of reflection is about asking yourself why was the teaching approached in a certain way; rather than focusing on the procedural aspects of what the student did next while teaching. This is where student teachers can think about their rationale for teaching concepts in a particular way (Kreber & Cranton, 2000).

Reflection can be a critical tool for assisting prospective teachers when they teach mathematics. Reflection is a useful tool, also when teaching mathematics. Mathematics, unlike other subject areas is unique in its tenets, concepts and principles. Reflection can also guide prospective teachers in integrating mathematical processes such as problem solving, reasoning, justification and questioning before and after reflecting on a lesson. In mathematics teaching specifically, the application of mathematical processes such as problem solving, justification, reasoning and questioning if not explicitly taught to prospective teachers during the lesson preparation and reflection stages, could lead to gaps in their knowledge of how to teach mathematics effectively. These gaps could be a result of the lack of unclear mentoring approaches for mathematics teaching. Prospective teachers often experience uncertainty when a decision is needed about the best methods to teach a particular mathematics concept (Rowland & Turner, 2007). Such uncertainty is normal and serves as an example of the developmental stages evident during teacher training when student teachers are at pains to morph CK and PK as PCK. Initially, most of student teachers' teaching examples are procedural and dependent on the exact demonstrations that they see from their mentor teacher's teaching. (Edwards & Protheroe, 2004).

1.8 Research Methodology

The research design for this study can be classified to a generic qualitative study. In generic qualitative studies, data collected during this study will be analysed and interpreted in order to make sense of it (Henning, van Rensburg & Smit, 2011). A qualitative study, such as this one, aims to understand how participants make meaning of their surroundings and how this influences their behaviour or thoughts (Wolcott, 2001). Qualitative research is characterised by its aims, which relate to understanding some aspect of social life, and its methods, which generate words, rather than numbers as data for analysis (Henning et al, 2011). My intention with this study is to gain better insights as to how student teachers benefit from mentoring and how mentor teachers approach mentoring of mathematics. Qualitative approaches are concerned with analysing data from an inductive to a deductive approach. In this particular study, the aim is to understand the educators and student teachers thoughts, opinions and ideas regarding the mathematical processes and assess how student teachers benefit from mentoring, for mathematics lesson planning.

1.9 Research Design

A generic qualitative research design occurs in naturalistic settings and the phenomenon is studied in its natural environment (Lincoln & Guba, 1985). In qualitative studies, the researcher seeks to understand the participants' experiences within that context (Maykut & Morehouse, 1994). De Vaus and der Vaus (2001) describes a research design as the overall strategy that a researcher uses to integrate the different components of the study in a coherent and logical way, to ensure that they effectively address the research problem. The design of the research serves as a basis for collecting and analysing the data (Labaree, 2009).

1.10 Sampling

The sampling criteria for this study was purposeful. The selection consisted of three experienced teachers in a teaching school who are teaching mathematics and mentor foundation phase students in their third year of a four-year qualification. Individual interviews with the mentor teachers were used to gather one set of data. The aim of the individual interviews was to capture each teachers experiences regarding mentoring and find out the kinds of mathematical processes they engage student's teachers in. A sample of two groups of students, which consisted of six students per group, were interviewed in focus group format. The aim of the focus group interview was to gather information about student teacher's experiences concerning mentoring and their awareness of mathematical processes, when planning and teaching mathematics.

1.11 Data Collection Methods

The data was collected through focus group interviews for student teachers and individual interviews for mentor teachers. The purpose of the focus group interviews was to uncover student teacher's views about their experiences with the processes of mentoring. Student teachers observe and teach at the teaching school in groups and I saw it fitting to interview them in groups as well. Similarly, the purpose of the individual interviews with the mentor teachers was to understand the mentoring practices they engaged student teachers in for mathematics teaching.

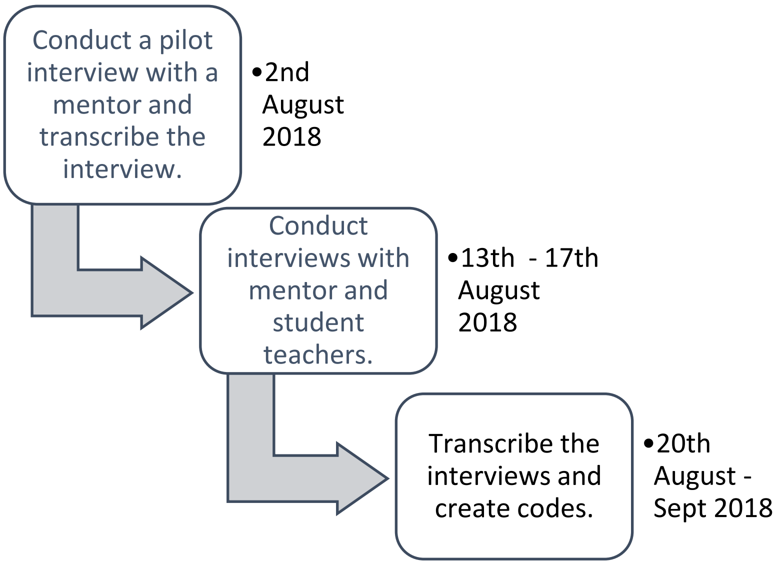


Figure 1.11.1 Data collection time-line for the study

1.12 Data Analysis

The data collected from the interviews will be transcribed and will be analysed using the *Constant Comparative method* (Glaser & Strauss, 1967). From further analysis will create provisional categories using Maykut and Morehouse's (1994) 'look/feel-alike method. These provisional categories will be further analysed using this method to create categories. The categories will highlight result in overarching themes that will be used as a basis for an argument and discussion (Henning et al, 2011).

1.13 Research ethics

In order to undertake the study I needed to abide by the University's ethics protocols. An application was submitted to the Faculty of Education ethics committee for ethics clearance. Letters accompanied by a description of the study were given to the student teachers. These letters asked permission to conduct the study, and consent to participate in the study, including videotaping lessons. Letters issued to the participants stated that the participants' anonymity and confidentiality would be guaranteed, and they were provided with the assurance that they could withdraw from the study at any time. I tried to act ethically in the field by respecting and appreciating the teachers and student teachers participating in this study and put all participants at ease.I was also careful and sensitive to any of their concerns and information they shared.

1.14 The structure of the dissertation

Chapter One: This chapter consist of the background and motivation for the study as well as the aims and objectives, with some core literature that that lays the foundation for the study.

Chapter Two: The literature study concerning existing theoretical tools for mentoring prospective teachers and the theoretical framework.

Chapter Three: The design of the study is set out.

Chapter Four: The data analysis process is exemplified with a portrayal of the analysis from 'raw' data to findings.

Chapter Five: The findings of the study are discussed

1.15 Conclusion

The study aimed at examining mentor teachers and student teacher's experiences and perceptions of mentoring and their views about the the development of PCK for mathematics teaching. Reassured that mentor teachers experiences with mentoring would provide useful insights into the mentoring practice they engage student teachers in. Subsequently, student teachers views about their experiences in the teaching school would be able to refute or align with mentor teachers mentoring practices.

CHAPTER 2:
LITERATURE REVIEW

2.1 Introduction

The need for effective mathematics teaching is important for in-service teachers. More importantly for student teachers who are in training to become teachers. Studies conducted by numerous South African authors Rusznyak (2014); Fonseca and Petersen (2015), Reed and Taylor (2014) found that student teachers enter into initial teacher education programmes with poor mathematics content knowledge. This raises concerns about the kind of PCK they will develop in the course of a four-year B Ed programme. Mentoring during the practicum could be useful for improving student teacher's PCK more specifically the mentoring student teachers engage in at the university-affiliated teaching school in Johannesburg. The nature of the teaching school as a 'laboratory' is an effective place for improving student teacher's PCK. In this chapter, I specifically discuss the importance of mentoring for mathematics teaching and factors, which affect mentoring student teachers during mathematics teaching. In this section, I discuss how mentor teachers' mentoring practices in making their 'thinking visible' for student teachers can be an effective way of improving student teachers' PCK. This is because the mentor teacher's practice needs to be clear and explicit for student teachers to be able to learn form that practice.

2.2 The transition from traditional apprenticeship to cognitive apprenticeship

In the seminal work by Collins, Brown and Holum (1991) entitled Cognitive apprenticeship: *Making Thinking Visible*, the authors contrast a traditional apprenticeship with what they term a cognitive apprenticeship, in which expert mathematics mentor teachers make their thinking visible to novice teachers. I believe this article holds particular value for my discussion on the processes involved in mentor teachers guiding student teachers of mathematics in the development of their PCK. I first discuss Collins et al, (1991) views of the process of traditional mentoring and its limitations for developing reflective practices for mentor teachers and student teachers.

Following this, I discuss how cognitive apprenticeship can make the mentoring for mathematics teaching more effective.

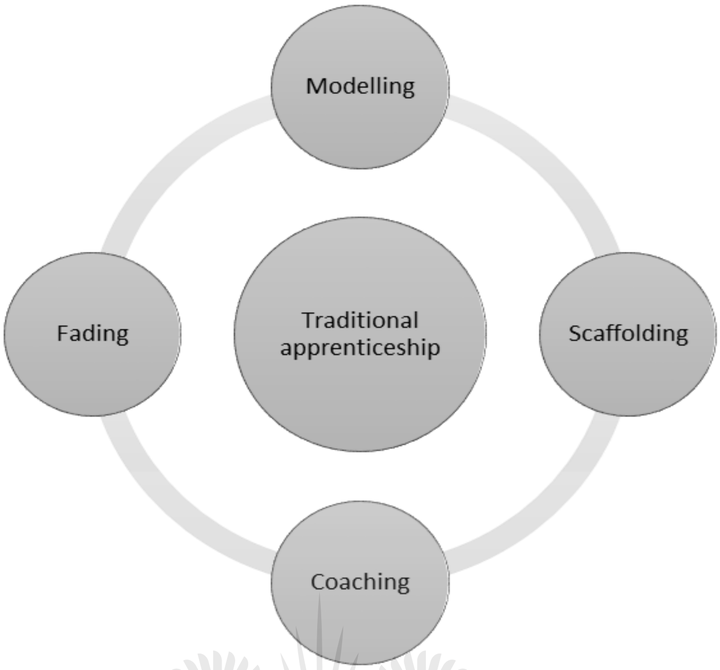


Figure 2.2.1 Principles of traditional apprenticeship (Collins et al, 1991:39)

In a traditional apprenticeship, the expert shows the apprentice how to do a task and watches as the apprentice practices portions of the task. More responsibility is given to the apprentices when they can demonstrate proficiency in accomplishing the task independently (Collins et al, 1991). A traditional apprenticeship consists of four aspects namely: scaffolding, modelling, coaching and fading. The term scaffolding refers to a process in which teachers or a more knowledgeable other demonstrate how to solve the problem and then then steps back from offering support as needed (Vygotsky, 1978). The theory is that when students are given the support they need while learning something new; they stand a better chance of using that knowledge independently. Modelling, in traditional apprenticeship is when the apprentice observes the master demonstrating how to do different parts of the task (Collins et al, 1991). The master or mentee models the skills, which the mentee should learn. In traditional apprenticeship, much of the learning occurs as apprentices watch others at work (Lave & Wenger, 1991). Once the mentee has observed the practice, the mentor in applying the skills, which they have observed, should guide them.

The process of overseeing the student teachers' learning is what Collins et al (1991) refers to as coaching. This aspect of apprenticeship is about how mentor teachers guide student teachers, provide useful hints on how to approach teaching concepts and includes evaluating the activities student teachers engage in. In a practice teaching setting, the mentor teacher oversees the process of student teachers teaching mathematics concepts. Part of the mentor's responsibility is to evaluate student teacher's lessons and to provide feedback (Danielson, 2002). Once the apprentice has grasped the skills, which were taught, then the process of fading occurs – this is what Collins et al, (1991) describe as slowly removing the support from the mentee and giving more opportunities to work individually. I am in agreement with Collins et al (1991) that the limitations of traditional apprenticeship do not allow student teachers to learn the thinking process behind the mentor's actions or understand what informs their practice. Rather the focus is on the mastery of skills of how to teach particular mathematical concepts.

The transition from a traditional apprenticeship to cognitive apprenticeship differs in a sense that cognitive apprenticeship involves mentors making their thinking, which informs their actions, visible for the mentee. Unlike in a traditional apprenticeship, which is about the mastery of skills that the mentee learns from the mentor (Collins et al, 1991), in a cognitive apprenticeship, there should be a shift from the mentor demonstrating skills to elaborating on what informed their thinking. Student teachers should be able to understand the mentor teacher's pedagogic choices and the theory that informs those choices (Hudson & Hudson, 2011). This can be achieved through the discussions between the mentor teacher and the student teacher. These discussions become a fundamental process for helping the student teacher's understand the mentor teachers' choice of pedagogy and how student teachers can use these pedagogies in their own teaching (Hudson, 2007). This method of mentoring is important for ensuring that student teachers are able to critically think about the mentor teacher's pedagogy and use what they learn from reflection process to improve their own pedagogy.

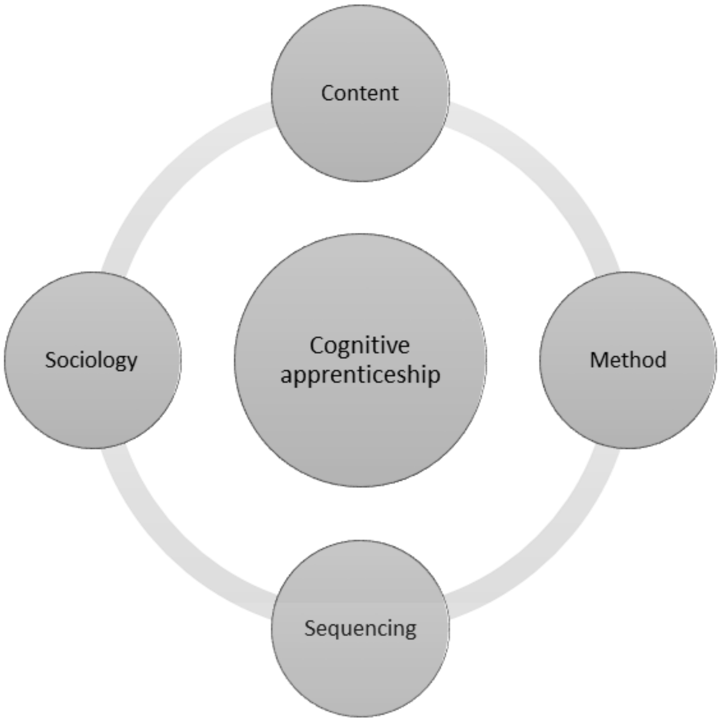


Figure 2.2.2 Principles for designing cognitive apprenticeship environments (Collins et al, 1991)

In a cognitive apprenticeship, student teachers are led to an understanding of, and gain insights into, the cognitive choices for teaching that mentor teacher makes. Here, student teachers through engagements with the mentor can begin to understand the thinking behind the use of a teaching method. Furthermore, they gain insights as to how the pedagogy unfolded in a lesson and why a mathematical concept was taught in a particular way. A wide range of perspectives, including that of cognitive psychology (Anderson, 2006), supports the idea of mentoring beginning or student teachers as a process that requires one to understand how another person thinks.

Leinhardt, Young and Merriman (1995) suggests that in developing conceptual understanding of teaching pedagogies mentor teachers should be aware that student teachers need to be explicitly taught the thinking behind the teaching methods during mentoring. Leinhardt (1993) furthermore argues that the mental structures of expert teachers differs from those of novice or student teachers. This means that expert teachers might be more aware of the thinking behind their practice. However, if novices are to learn that this is a normal part of teaching, this thinking process should be made explicit for student teachers. Feiman-Nemser (2003) is of the view that the mentor teacher's teaching and what informs that practice, is not always visible to student teachers and if student teachers have to learn it, it should be made visible to them. It is here that the principles of a cognitive apprenticeship as explicated by Collins et al (1991) which include content, method, sequencing and sociology.

The content domain involves the knowledge about the subject matter specific concepts, facts and procedures. It also includes the heuristic strategies which are the techniques required for completing tasks. Heuristic strategies are the approaches for directing the process of finding solutions to tasks. Often when student teachers are being mentored, there is more focus on this aspect. Schoenfeld (2016) suggests that heuristics skills in mathematics are important, as they form part of developing procedural fluency. Learning strategies refers to the knowledge about how we learn new concepts, facts or procedures (Collins et al, 1991). Learning new concepts is part of learning and is something, which student teachers need to be understand - they will be constantly teaching learners new facts and mathematics concepts.

The method in cognitive apprenticeship is about how teaching methods should be designed to allow student teachers the opportunity to observe, engage in and discover effective strategies, which are suitable for their context. Core principles of this domain are modelling, scaffolding and coaching where the mentor teachers make their thinking visible through the teaching methods observed by student teachers.

Sequencing in teaching mathematics, is the development of global skills before local skills (Lave & Wenger, 1991). This means that student teachers need to understand broad mathematics content, before they can attempt to teach specific mathematical concepts. Ideally, student teachers should a conceptual understanding of the content area before teaching specific skills within the various topics. Another aspect of sequencing involves understanding the levels of complexity for various mathematics tasks. Mathematics concepts in the curriculum are designed to increase in the level of complexity and it requires learners to have a solid understanding of one concept before moving onto the next one. As student teachers are coached and scaffolded, they develop competence in mathematics teaching.

Sociology in cognitive apprenticeship refers to the social characteristics of mentoring (Collins et al, 1991). Student teachers learn when they are in environments where they are actively constructing their knowledge, rather than passively receiving knowledge (Lave & Wenger, 1991). Mentoring assists student teachers in learning how to use different pedagogies in teaching mathematics is most effective in a community of practice. Moreover, mentoring should enable student teachers to communicate their thoughts about how mentoring develops their teaching practice. Mentoring that is aligned to a cognitive apprenticeship is a form of situated learning (Lave & Wenger, 1991). Situated learning occurs when student teachers learn in the context of working on realistic tasks (Collins et al, 1991: 49) which student teachers are interested in doing. Intrinsic motivation plays a key role in motivation for learning (Lepper & Greene, 1979). Student teachers need to be intrinsically motivated to teach and communicate how they develop teaching skills, which enhance their overall practice.

The framework on cognitive apprenticeship can make the mentor teacher's thinking less abstract and student teachers can understand what theory informs the pedagogy (Collins et al, 1991). Schoenfeld's (2016) TRU Maths framework correlates with Collins et al (1991) model on mentoring. In the next section, I discuss how the TRU Maths framework (Schoenfeld, 2016) is appropriate for mentoring student teachers to teach mathematics effectively.

2.3 Theoretical framework

A theoretical framework is a lens, which guides the overall research (Lederman & Lederman, 2015). In this study, Schoenfeld and Floden's (2014) theoretical framework, which was later refined by Schoenfeld (2016) as the *Teaching for robust Understanding (TRU Maths) as a framework* guides this study. Firstly, this framework provides a theoretical lens for analysing mentoring practices of expert teachers and secondly, teaching mathematic for robust understanding. Schoenfeld (2016) elaborates on five domains of mathematics teaching, which mentor teachers can use to mentor student teachers. One of the tasks of mentor teachers at the teaching school is to mentor student teachers in developing adequate lesson plans. This framework could serve as an effective guideline for approaching mathematics lesson planning and evaluating student teacher's mathematics lessons taught in the foundation phase. The domains in this framework are discussed in this section to follow.

Schoenfeld's (2016) framework on Teaching for Robust understanding (TRU Maths) is a tool, which looks at key elements that important for lesson planning. He presents this tool in a form of a rubric as a guide for teachers, when assisting student teachers' with lesson planning. In this framework, he present five main domains that need to be included in lesson planning. These are content, cognitive demand, equitable access to content, agency, ownership and identity and the last domain is formative assessment.

Content

This domain is concerned with the extent at which the classroom activity allows the learners to "become knowledgeable, flexible and resourceful and flexible disciplinary mathematical thinkers" (Schoenfeld, 2018:1). The mentor teacher needs to ensure that student teachers teach meaningful and informative mathematics content.

Cognitive demand

In a mathematics classroom, cognitive demand refers to the opportunities provided to learners to engage in range of cognitively difficult mathematics tasks. Mentor teachers need to mentor student teachers to set mathematics tasks range from moderate to tasks demanding higher order thinking. In addition, the tasks selected should provide learners with meaningful opportunities to learn and to make use mathematics content. Schoenfeld (2018) pointed out how learners need to engage in 'productive struggle' to make sense of the mathematics content.

Equitable access to the content

Learners need to be given the opportunity to engage with a particular content area, theme or topic. Equitable access involves teaching the content in a manner that address each learners needs. For instance, learners who struggle with mathematics would require more opportunities with the content. In our context, the CAPS (2011) policy document provides guidelines as to the number of hours teachers should teach mathematics per week. Equity in mathematics is about addressing learners' needs on merit. Mentor teachers should guide student teachers in applying differentiated learning techniques because learners do not grasp mathematics concepts in the same manner (Fleisch, 2008).

Agency, ownership and Identity

This is the extent to which learners are provided opportunities to contribute to mathematical discussions, concerning how they would problem solve. Mentor teachers can guide student teachers in ensuring that they allow learners to contribute to discussions about problem solving. These discussions promote critical thinking in the learners and the feedback from the learners could enhance the reflective process of the mentor and student teachers (Schoenfeld, 1985). Learners' discussions in cooperative learning groups creates a sense of ownership for learners because they contributed to the problem solving. As a result, learners develop a perception towards mathematics, which leads to their identity towards mathematics.

Formative Assessment

Mathematical assessments should elicit the learner's critical thinking and deepen their understanding (Schoenfeld, 1985). This can only occur if the teaching methods developed and stimulated critical thinking, when learners are engaged in problem solving activities. Mentor teachers need to mentor student teachers that assessment forms an integral part of teaching. The teacher's pedagogical content knowledge (PCK) can have an influence on the learner's performance in mathematics tasks.

The TRU Maths framework can thus be used during lesson planning when student teachers are required to think deeply about the desired content knowledge (CK), pedagogical knowledge (PK) and PCK for a specific mathematics lessons. In the following section, I discuss how the TRU Maths framework (Schoenfeld, 2016) links with the seminal work by Collins, Brown and Holum (1991) about the transition from traditional apprenticeship to cognitive apprenticeship for the purposes of mentoring student teachers to teach mathematics. In the following section, I discuss the problems associated with initial teacher education (ITE) programmes, in training prospective foundation phase teachers and what can be learnt from ITE research.

2.4 South Africa's poor history of mathematics teaching

South African learner's poor performance in mathematics and languages has been a major reflection of the quality of the education system. Mathematics competence is important for the social and economic development of a country (Taylor, 2007), and is often viewed as strong indicator for the potential to improve a country's social and economic development (Reddy, Menkveld & Bitzer, 2008). It is thus important for a country to measure its performance in this key subject area (Reddy et al, 2008). This is particularly so in South Africa which has a history of marginalized access to quality mathematics teaching.

After 1994, there were wide-ranging changes to the national school curriculum (Botha, 2010) with one of the first being the introduction of Outcome Based Education (OBE) in 1994 by the department of basic education. OBE as it commonly became known as in South Africa, was focused on the outcomes of the educational process, meaning that teaching practices were aimed at ensuring that learners could meet particular developmental outcomes at their own pace. With the focus on learners, it was assumed, would lead to an increase in the quality of education for South African school learners (Botha, 2010).

Teachers felt disempowered by the language of the curriculum because it was not very explicit in guiding them how to implement the changes in their teaching. The changes in the curriculum from the OBE curriculum to the NCS curriculum resulted in a lack of resources suited to the requirements of the curriculum. This did not make teaching mathematics any easier because of the lack of resources. Teachers are often frustrated by curriculum changes because of they are unable to interpret the curriculum and as a result, it affects how they carry out their teaching responsibilities. Teachers often lack the theoretical knowledge and familiarity with principles informing the implementation of curriculum change (Mdutshane, 2006)

Building on the base of the NCS (2005) curriculum, a new curriculum was developed between 2007 and 2010 and formally introduced in 2011, called the Curriculum and Assessment Policy Statement (CAPS). The implementation of the Curriculum and Assessment Policy Statement (CAPS) was an important step in promoting educational reforms especially between former resourced and under-resourced schools. The CAPS document brings about significant changes in the types of assessments learners are required to do and significant changes in the time allocations for the various learning areas from grade R-12 and consists of new teaching approaches (Maharajh, Nkosi & Mkhize, 2016). Magano (2006:2) argues that “changes in curriculum policy may lead to greater changes in the teachers need to teach learners and the way learners learn in the classroom”. A change in curriculum therefore necessitates a change of the function of the teacher (Maharajh et al, 2016) and these changes should not be implemented haphazardly but rather through systematic phases which will ensure that teachers know what is required of them.

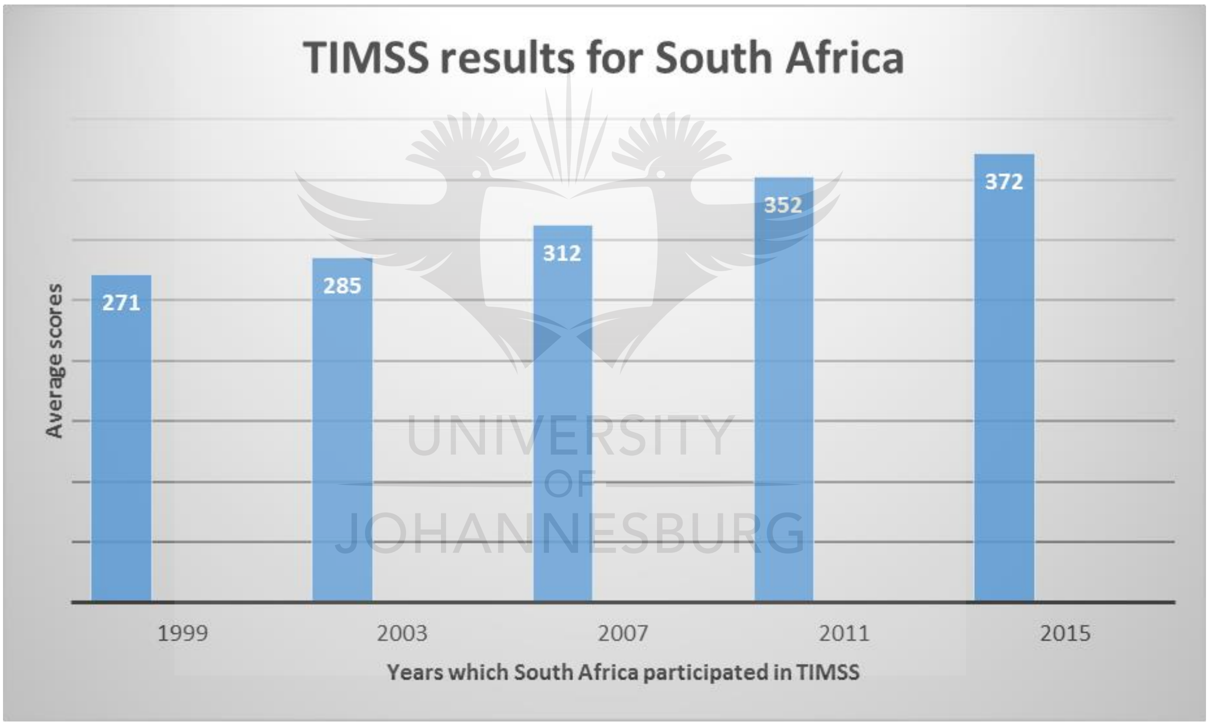
The CAPS curriculum is the current education policy for teaching in South Africa. Researchers such as Botha (2010), Henning, Van Rensburg and Smit (2011) and others argue that in South Africa so many changes in the curriculum over the past 24 years is an issue for concern for many reasons. Chief among these is the difficulty in interpreting principles pertaining to new ways of teaching (Maharajh, Nkosi & Mkhize, 2016). I concur and argue that the rapid changes in the curriculum negatively influenced teachers' confidence in their ability to teach learners effectively. While some such as Magano (2006) argues that the curriculum changes were accompanied by training for teachers, others (Jansen & Taylor; 2013) argue that the nature, form and duration of the training was inadequate and that expecting teachers to cope with many rapid changes in a very short period of time was bound to impact negatively on learner's results.

For instance in mathematics, hasty shifts in the composition of the curriculum has led to problems for the structure of primary school mathematics, particularly in the lower grades. Here, both practicing teachers and educational researchers argue that the curriculum is very full, comprises many concepts to teach in the various grades (Mdutshane, 2007). Many concepts are introduced before learners are actually ready for them (Fritz,Ehlert & Balzer, 2013) and that the pace at which teachers have to teach in order to complete the curriculum for each grade is unmanageable and unrealistic. This gives learners little time to consolidate their learning. As a result, learners are struggling to cope with the content and the pace of the curriculum and risk falling behind.

In South Africa, mathematics is a compulsory subject for learners in grade 1-9 and forms part of the core curriculum for learners in the foundation, intermediate and senior phases. Over the past two decades, South African learners' results in this subject area as measured in international assessments such as the *Trends in International Mathematics and Science* (TIMSS) from 1999 – 2015, in the Southern and Eastern African Consortium for Monitoring educational Quality (SAQMEQ) from 2000 – 2013 and national studies such as the Annual National Assessment (ANA) from 2012 – 2014 show increasingly poor learner outcomes. I am particularly interested in the findings of learner's performance in mathematics in the primary school because of the focus of this study.

The Trends in International mathematics and Science (TIMSS) is an assessment of mathematics and science knowledge of grade four and eight learners around the world (Reddy et al, 2008). This international testing programme was developed by the International Association for the Evaluation of Educational Achievement (IEA) and is administered in over fifty countries in order to track countries progress in education over time (Reddy et al, 2008). TIMSS was first introduced in 1995 and was administered every four years thereafter. South Africa participated in 1999, 2003, 2007, 2011 and 2015. In all the years of its participation. The results show that South African learners are consistently in the five lowest performing countries with learners scoring well below the average achievement at the lowest level. TIMSS defines four benchmarks for scoring namely: scores between 400-475 are classified as achievement at a low level, scores ranging from 475 – 550 are classified as achievement at an intermediate phase level, scores ranging from 550 – 625 are regarded as achievement at a high level and scores above 625 are classified as achievement at an advanced level (IEA, 1995). The following graphs (taken from the TIMSS Results for grade 9 learners performance, 2015) indicates South African learner's poor performance in mathematics assessments from 1999 – 2015.

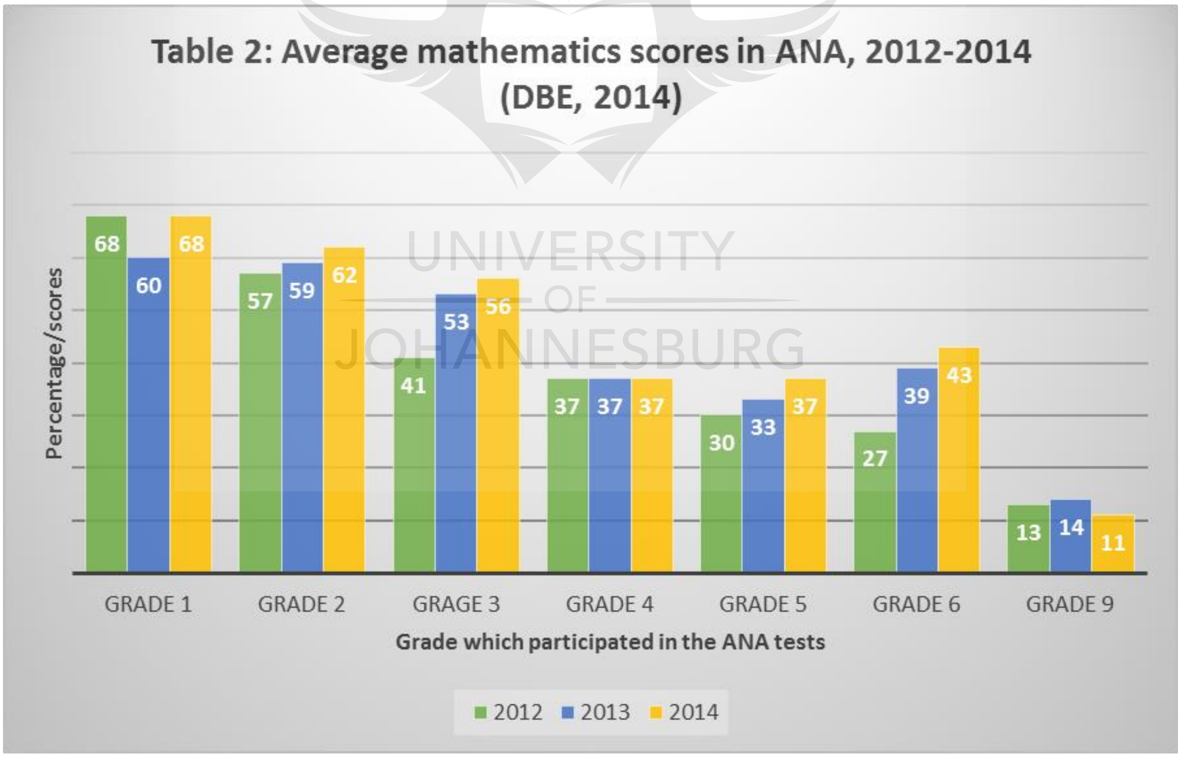
Table 2.4.1 South Africa's performance in TIMSS assessments (Reddy et al, 2008)



Despite a small upward trajectory in learner scores over the period of testing from 1999 to 2015, the latest scores are still way below the achievement at a low level, which ranges from 400 - 475. The consistent underperformance of learners over a many years indicates that there are huge challenges with mathematics teaching in the primary school. If by grade nine learners still do not know and understand mathematics content they exit the primary school phase with poor understanding of mathematics content (Luneta & Olusola, 2015) and this is bound to create problems for mathematics teaching and learning in the high school years.

Learner results in another set of national tests show similar results. The introduction of the Annual National Assessments (ANA) in 2012 – 2014 as a curriculum-based test provided another perspective of learner's poor performance within the curriculum. The Department of Basic Education used the ANAs to assess learner's performance in mathematics and reading in grades 1-6 and in grade 9 as the exit grades for a particular phase of schooling in all public schools in the nine provinces. Schools administered the tests themselves, with senior management having to oversee the entire process (Mbatsha, 2013). Mathematics in grade nine is done in English, in schools where English is the language of teaching and learning. There was some criticism of the ANAs with the translation of the test items into other South African languages being deemed particularly problematic (Dhlamini, 2016) due to its impact on the meaning of items and how this would influence learners' performance. The following table shows the average ANA results per grade from 2012 -2014 for grades 1- 6 and grade 9. I will mainly confine my discussion to the results of grade nine learners.

Table 2.4.2 ANA mathematics results from 2012 – 2014 (DBE ANA Report, 2014)

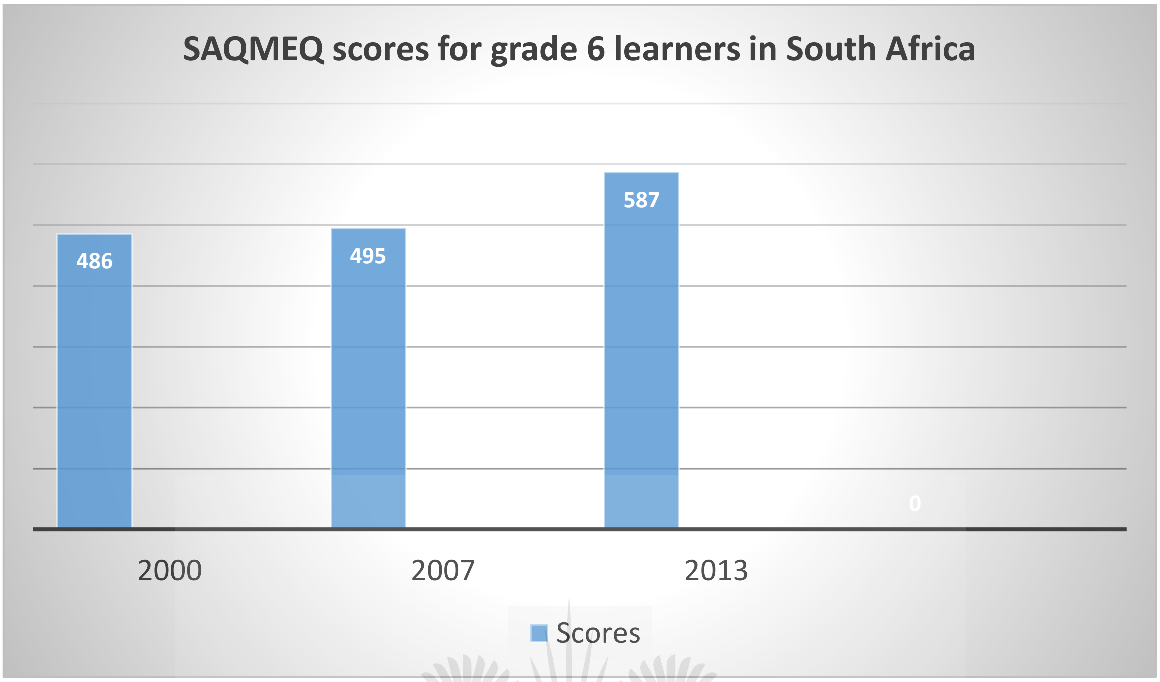


The results of these tests clearly show a significant decrease in learners mathematics performance from Grades 4 onwards, as they progress from the foundation phase to the intermediate phase. The switch from mother tongue instruction to English in the intermediate phase in Grade 4 has long been recognized as a problematic area for mainly young African learners because this is the point at which learners make the transition from their home language to English (Pretorius, 2002). In the foundation phase the average grade 3 mathematics ANA results were 41% in 2012, 53% in 2013, 56% in 2014 and an average of 51% (DBE, Report on the ANA, 2014). The average scores for grade 4 learners was 37% for 2012-2014. The transition from mother tongue instruction to English could provide some insights into the significant decrease in the ANA assessment results from grade 3 to 4. Pretorius (2002) argues that without adequate competence in their mother tongue, learners may find it difficult to transition to learning in a second language. Learners need the skills they learn in their mother tongue in order to learn an additional language.

There is also an almost consistent downwards trend right up to Grade 9 with a tangible difference in learner scores from grade 6 to grade 9. In the province of Gauteng, the provincial education department (GDE) as a result implemented a targeted plan to improve learner results and improve curriculum coverage in English and mathematics – these were known as the Gauteng Province Language and Mathematics Strategy (GPLMS) implemented from 2013- 2015. This programme consisted of a task based support plan, comprising activities, which could be used in conjunction with learner's textbooks and workbooks. The exercises detailed activities, which learners had to complete in class and at home, as a means of providing support in mathematics and language. This however, did not yield the expected results, as it later emerged that teachers were not effectively using this resource to support learners (Mdutshane, 2007). Learners were also often not guided and were left to complete these tasks on their own. As the monitoring of the implementation of this programme was the responsibility of the schools, inconsistencies in this sphere lead to uneven interventions across affected schools to improve learners' results (Chetty, 2015 & NEEDU Report, 2012).

A third set of tests, namely the SAQMEQ ii (2000), SAQMEQ iii (2007) and SAQMEQ iv (2013) tests which provide a barometer for understanding a) the general conditions of schooling, b) the reading and mathematics achievement levels of Grade 6 learners and their teachers, and c) the knowledge that learners and their teachers have about HIV and AIDS. The results for South African learners' align with that of the other tests, showing a consistently poor level of achievement below the benchmark of 600.The following table shows the mathematics results for grade 6 learners.

Table 2.4.3 SAQMEQ mathematics results for South African grade 6 learners (Portfolio Committee on Basic Education, 2016)



Again, learners overall poor performance in mathematics reflected in these test could account for their poor performance in grade 9 because they exit the intermediate phase in grade 6 with weak content knowledge and continue to struggle with mathematics. This could be one of the reasons why many grade 9 learners chose to do mathematical literacy over pure mathematics from grades 10 -12. There is much anecdotal evidence that learner's poor performance in mathematics and their constant struggles with the subject in the upper grades of the primary school and the early years of the high school can result in a fear of mathematics, with many choosing mathematical literacy in the further education and training (FET) phase of schooling. There is also very little understanding of the power of mathematics as a gateway subject towards careers in the sciences, medicine, engineering and other sciences in post-school education. The Umalusi accreditation agency, which is responsible for issuing grade 12 results in South Africa, indicates that increasing numbers of learners' complete grade 12 with mathematical literacy instead of pure maths from when it was first introduced as a subject in 2008. As a result, learners who do not pure mathematics in the FET phase have limited options to degree programmes at a university level. Many then come either into humanities degrees or into initial teacher education programmes where the mathematics requirements are lower (Mbatsha, 2013).

This is problematic for initial primary school teacher education programmes because many students come into the programmes with poor mathematical content knowledge (Rusznyak, 2014). Entering students' poor mathematics content knowledge affects their ability to understand the content they will be required to teach and in many cases requires that universities put intervention programmes into place to improve students' mathematics content knowledge (Rusznyak, 2014; Fonseca & Petersen, 2015). While many intermediate and senior phase student teachers can choose to specialize in mathematics (or not), foundation phase teachers need to be competent teachers of mathematics, as they are classroom-based teachers who teach all subject areas in the phase (Danielson, 2002). For effective teaching of mathematics, all foundation phase teachers must have excellent subject matter knowledge (Shulman, 1987). This serves as a start as they set the base for better learner performance in mathematics further along the schooling chain.

2.5 The problem of poor mathematics content knowledge of student teachers

First year student teachers who enter initial teacher education programmes with poor mathematical content knowledge are more likely to continue to struggle with mathematics even if they are supported (Fonseca & Petersen, 2015; Rusznyak, 2014). Without support, they are bound to become poor teachers of mathematics themselves. For primary school teaching, particularly for the foundation phase, this is problematic as all FP teachers are mathematics teachers (Danielson, 2002). I use the definition of content knowledge as it is used in teacher education, taken from the work of Shulman (1986:9) who describes it as "the amount of knowledge of a subject matter and the organisation of this knowledge in the teacher's mind".

Ball, Thames and Phelps (2008) describe mathematical knowledge for teaching as a construct, which consists of two domains namely subject matter knowledge (SMK) and pedagogical content knowledge. Foundation phase teachers in my view need to have an in-depth understanding of mathematical concepts. These concepts build on each other to develop profound understanding (Ma, 1999). It is generally accepted that teachers need to have the required mathematics content knowledge beyond the grades they are going to teach - their MCK cannot be at the level of the learners they are going to interact with. Schoenfeld and Floden (2014) suggest that mathematics teachers in general need to have conceptual understanding of mathematics content before they can learn how to teach the concepts in the subject and before they can learn the concomitant teaching practices associated with various areas in mathematics (Hill, Schilling & Loewenberg-Ball, 2008).

In South African primary school teacher education, mathematics content courses are usually compulsory up to third or fourth year (Bowie & Frith, 2006) as there is a view that mathematics content courses are important for ensuring that student teachers learn mathematics content which they will need to understand in order to teach mathematics in this phase of education (Rusznyak, 2014). However, many students come into teaching with extremely poor mathematics content knowledge. Spaull and Kotze (2015) argue that this is likely due to the poor quality of instruction in their primary and secondary school education. There is ample evidence of this also from studies such as TIMSS (1999, 2003, 2007, 2011 & 2015) and SAQMEQ (2000, 2007 & 2013) where longitudinal data about poor learner's performance in primary school mathematics attests to this.

The poor performance of school learners in mathematics over the primary school years could be a major reason why many are channeled into the mathematical literacy stream over pure mathematics in grades 10-12 (Bowie & Frith, 2006). The South African National Policy Pertaining to the Programmes and Promotion Requirements (NPPPPR, 2015) of the national curriculum statement determines minimum outcomes and standards, as well as the processes and procedures for the assessment of learners in public schools. The progression and promotion standards and processes for the various phases are also included in the CAPS document. According to a National Assessment Circular released in December 2015, a learner who has met all the requirements for passing to the next grade but has not achieved 40 percent in mathematics and therefore has to be held back, should be condoned (allowed to proceed to the next grade) if their mark is higher than 20 percent.

Learners who receive less than 40 percent in grade 9 mathematics are often not allowed to choose pure mathematics but rather are encouraged to choose mathematical literacy instead in grades 10- 12 (DBE, 2006). Mathematical literacy was introduced in 2006 and was intended to ensure that all learners understand and achieve some level of competence in the basics of mathematics (Mbatsha, 2013). According to the Department of Basic Education (2003), mathematical literacy is a skills based subject area which is intended for learners to develop the ability and confidence to think numerically and spatially in order to interpret and critically analyse everyday situations and to solve problems. The central focus is on understanding how these skills are evident in daily life. Magano (2006) argued that concepts, which are taught in mathematical literacy, are not completely isolated from the mathematics content that is taught in the primary school. However, Bowie and Frith (2006) are of the view that learners with very poor mathematical content in grade 9 could still find mathematical literacy difficult because they lack basic understanding of the mathematical concepts that should have been developed at primary school level. In Table 2.5.1. I show a comparison of the content areas done in mathematics and those for mathematical literacy.

Table 2.5.1 Curriculum outline for Mathematics and Mathematical Literacy in the CAPS document (2011)

<table>
<tr><th>Content areas in Mathematics curriculum FET phase (grade 10-12)</th><th>Content areas in Mathematical Literacy curriculum FET phase (grade 10-12)</th></tr>
<tr><td>• Number and Number Relationships
• Functions and Algebra
• Space, Shape and Measurement
• Data handling and Probability</td><td>• Number and Operations in context
• Functional Relationships
• Space, Shape and Measurement
• Data handling</td></tr>
<tr><td colspan="2">Content areas for Mathematics in the Primary school (Foundation, intermediate & Senior Phases)
• Number operations and Relationships
• Patterns and Functions
• Space and Shape
• Measurement
• Data handling</td></tr>
</table>

It is important to highlight that even though there are some similarities in the content areas, the way in which the content is taught is not the same. In pure mathematics, concepts are taught with the aim of developing learners who can problem solve and reason abstractly whereas, in mathematical literacy the aim is to develop numeracy skills which can be used for daily life (DBE, 2003). Some of the topics in the CAPS document covered in mathematical literacy include the specifics of buying a house, such as for instance calculating transfer fees and bond repayment amounts, and also includes reading and interpreting statistics in newspaper articles and calculating income tax. These are practical skills, which are not the same as the type of abstract problem solving and reasoning which is done in pure mathematics. Here the content includes topics such as geometry, data handling, financial mathematics, probability and calculus. Mbatsha (2013) argued that even with the implementation of mathematics literacy, many learners are still not competent and perform poorly in the subject area even though it is less abstract.

There is also critique from mathematics teacher educators. Despite the implementation of mathematical literacy there were concerns about how teachers would be trained to teach this kind of numeracy and the kind of further training that would be required to ensure that teachers could teach this subject (Bowie & Frith, 2006; Graven & Venkat, 2008; Mbatsha, 2013). Training teachers was crucial to ensuring that there would be teachers to teach this subject because there is very little evidence to support the view that university teacher education programmes were training teachers to teach mathematical literacy (Graven & Venkat, 2008). Poor teaching instruction of mathematical literacy could further exacerbate and contribute to even poorer grade 12 results.

Umalusi, the accreditation agency in South Africa is responsible for issuing grade 12 national senior certificate results and their figures show that since the introduction of mathematical literacy with the first cohort of matriculants in 2008 to the most recent in 2017, more learners matriculate with mathematical literacy instead of pure mathematics (DBE Annual Performance Report, 2016/17). In 2015 of the 667,925 full-time candidates who wrote their final grade 12 exam 204,033 did pure mathematics and the remaining 463,922 candidates did mathematical literacy (DBE Annual Performance Report, 2016/17). Such figures clearly show the disproportionate skewing in favour of mathematical literacy, which means that a great many of the students enroll for initial primary school teacher education programmes will do so with mathematical literacy.

Many programmes such as the one at the university where I teach accepts students into the foundation phase teacher education programme with either mathematics or mathematical literacy at grade 12 level (Mbatsha, 2013). What concerns me, as a teacher educator is that many students enter teacher education programmes with relative competence in mathematical literacy even if they do not fully understand primary school mathematics content (Botha, 2010). I am also concerned about whether or not competence in mathematical literacy equips learners with the kind of mathematics content knowledge they need for becoming primary school mathematics teachers.

The introduction of mathematical literacy in 2006 created the need for more research on the teaching of this subject area, particularly because there was evidence that universities were not training teachers to teach mathematical literacy (Mbatsha, 2013). The training at the time was purely through the department of basic education workshops and trainings for teachers. Graven and Venkat (2008) conducted a study where they analysed grade 10 learner's perceptions of mathematical literacy in an inner-city Johannesburg school. The sample consisted of 66 learners spread across three mathematical literacy classrooms. The first author was a participant observer in each of the ML classes once a week across 2006 (approximately 75 lessons in total). This was done to gain deeper insights pertaining to learner's experiences to learning mathematical literacy.

The aim of the in-depth longitudinal case-study to study the participants in depth and over longer periods of time and understand how learners were learning and perceiving the subject. Data was collected through scaled questionnaires and nine students were selected randomly for the individual interviews. The major finding in this study was how learners expressed enjoyment and the feeling of being relieved at being able to do mathematical literacy instead of pure mathematics. There was a strong sense of enjoyment associated with mathematical literacy. In the open section of the questionnaire 83% of the learners (55 out of 66 learners) used different versions of the synonym 'enjoy' such as: 'fun, wonderful, cool, interesting, like or loving' to describe their experiences with mathematical literacy (Venkat & Graven, 2008: 33). The general assumption with this particular study is that learners enjoy mathematical literacy in comparison with their prior experiences with mathematics. In the same sample of learners, 86% of them (57/66) expressed in the survey that they dislike mathematics experiences in grade 9.

I find that such findings could be a representation of many grade 10 learner's experiences. Graven and Venkat (2008) also suggest that many learners who opt to do mathematical literacy in grade 10 often had negative experiences with mathematics in grade 9 and possibly in the other lower grades. Their peers in the mathematics classes seen as not being intelligent enough labeled another issue that I picked up it the findings of the study by Graven and Venkat (2008). Learners also expressed that they had fear of mathematics and opted for mathematical literacy. Mbatsha (2013) shares insights about the labelling and stigmatization that mathematical literacy students face. Such insights are crucial to understanding why more learners are choosing mathematical literacy.

2.6 What can be learned from ITE research?

I turn next to studies in ITE research. Bowie and Reed (2016) conducted a five-year longitudinal study on five higher education institutions, which produce 49% of Bachelor of Education graduates. One provision I would like to mention was that this research was conducted with programmes that have since been re-curriculated. However, I still think there is value in some of the findings. The study was initiated by JET Education Services and in collaboration with the Education Dean's Forum, the Department of Higher Education and Training and the Department of Basic Education. The focus was on evaluating the overall coherence of the curriculum design for intermediate phase mathematics and English content and methodology courses. The five institutions participated voluntarily in the study. In discussion with the DHET and the DBE the five institutions were selected using the following criteria: the location (rural or urban), institutional history (formerly advantaged or disadvantaged), mode of programme delivery (contact and/or distance), and size of the annual ITE graduations (Bowie & Reed, 2016).

The universities were composed as follows:

1. University A, an urban formerly advantaged university, which offers initial teacher education by full-time contact mode on a single campus.
2. University B, an urban university that formed as a result, of a merge from a formerly advantaged and disadvantaged. This university offers initial teacher education partly by distance and partly by contact on multiple campuses.
3. University C, is a distance education university with regional centres throughout the country and annually graduates the largest proportion of new teachers.

4. University D, a rural formerly disadvantaged university offering initial teacher education by full-time contact mode on a single campus.
5. Lastly University E, an urban university merged from a formerly advantaged and disadvantaged university of technology. It offers initial teacher education by full-time contact mode on multiple campus sites.

Collectively at the beginning of this study in 2012 these five case study universities graduated 7 437 (54.3%) of the country's total of 13 708 new teachers (DHET, 2013: 4). My interest and focus is on the curriculum design for the mathematics courses offered in these institutions. At Institutions A, C and E, student who did mathematical literacy for matric were still able to specialize in mathematics. Both institutions A and E consider students' performance in the institutions' own tests for admission, which enables students with relatively low grade 12 maths marks (40% - 50%) to be accepted as IP maths students. The following table provides an outline of the mathematics courses for prospective intermediate phase maths teachers.

Table 2.6.1 Basic information about the mathematics offering for prospective IP teachers not specializing in mathematics (Bowie, 2014)

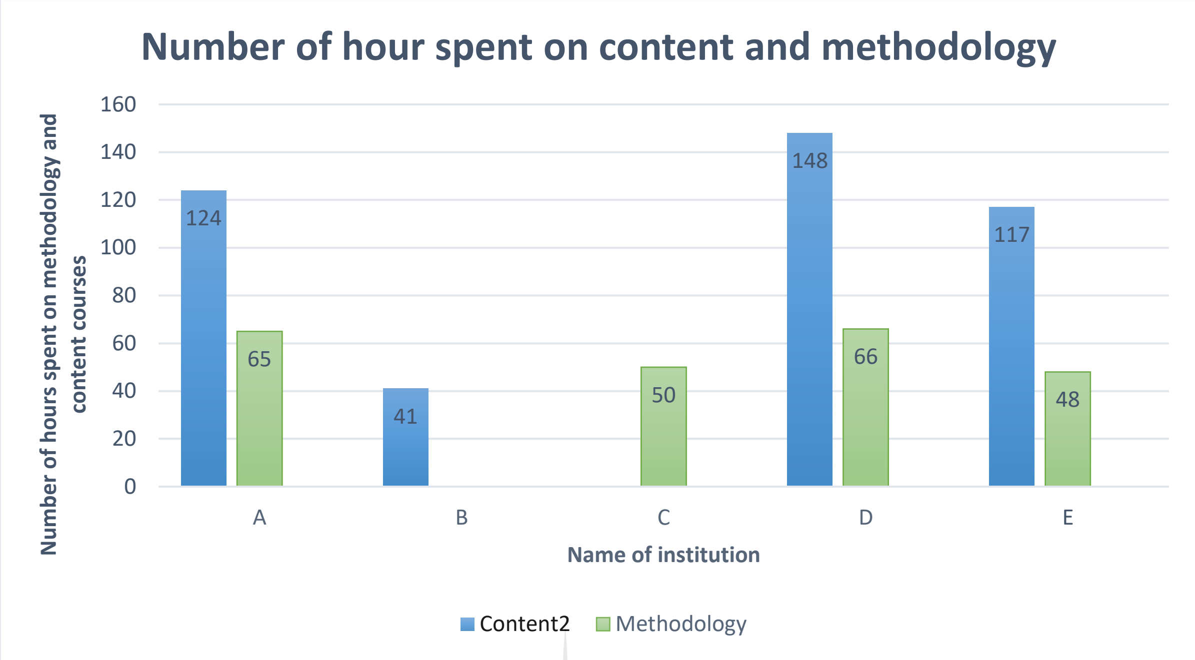
HEI	Approximate number of IP students	Maths credits	Percentage of total credits	Support provided
A	75	40	8%	Tutorials for the compulsory maths course.
B	120	16	3%	Senior students
C	1600	12	2.5%	One optional tutorial per semester for some courses
D	312	68 (ML)	13%	None
E	55-80	19	4%	Mastermaths, tutorials, peer tutoring

Bowie (2014) uncovered that there are vast differences in curriculum design and the support provided to students within the five universities. In three of these institutions (A, C & E) students who had done mathematical literacy were allowed to specialize in mathematics teaching in the intermediate phase. Questions can be raised about the effectiveness of the support, which was offered to students who had previously done mathematical literacy. The assumption we can make based on the findings by Mbatsha

(2013), Graven and Venkat (2008), Bowie (2014) and Bowie and Frith (2006) argue that many students who enter into initial teacher education programmes with a background in mathematical literacy need support to develop mathematical proficiency. This includes being able to think abstractly and engage in abstract problem solving. A student might have passed mathematical literacy well at the end of grade 12 but teaching primary school mathematics is different from the content the student learns in mathematical literacy. This is because pure mathematics is based on engaging in problem solving which requires abstract thinking and reasoning.

Proficiency in mathematical literacy skills might not necessarily mean that students will be able to understand pure mathematics content in a university teacher education programme. I strongly believe that universities who accept students to specialize in mathematics teaching in the primary school should offer adequate support for assisting student teachers in improving their mathematics content knowledge up to a grade 9 level adequately. Mathematical content knowledge is important for primary mathematics teaching because teachers need to understand the content they are going to teach extensively. Initial teacher education programmes need to ensure that adequate time is spent on developing student teachers MCK because it can strengthen their pedagogy for teaching mathematics. However, this does not always find expression in the design of many teacher education programmes. Using the example of the five institutions earlier, the following graph shows the number of hours spent of mathematics content and methodology courses for the five case institutions in this study.

Table 2.6.2 Number of contact hours spent of mathematics content and methodology courses in a four-year B Ed course



The results indicated on this table indicate that more time in four of these institutions is spent on mathematics content classes, rather than on methodology courses. Thus more time was spent on trying to get student teachers to achieve mathematical proficiency for the content which they should know and understand. Ma (1999) describes mathematical content knowledge as a comprehensive understanding of mathematics, which has breadth, depth, connectedness and thoroughness. Novice and experienced teachers who lack adequate mathematics content knowledge are most likely experience difficulty when teaching mathematics concepts which they themselves do not understand. However, in the five case studies it does mean that the development of pedagogical content knowledge may have been neglected.

I argue that if students already have mathematical content knowledge then more time can be spent on methodology because it is the essence of why students enter into initial teacher education. Furthermore, if student teachers have adequate mathematical content knowledge then they already understand the content they are going to teach learners, more time can be spent on methodology courses to ensure that student teachers are well prepared to teacher learners. More time spent on methodology can be effective in developing student teacher's PCK (Hudson & Hudson, 2007). In this particular context, methodology courses should be aimed at developing student teacher's mathematical pedagogical content knowledge (Hudson & Hudson, 2007).

2.7 Research on first year student teachers' MCK and its impact on developing PCK

As a teacher educator, I believe that mathematical content knowledge for mathematics student teachers in the primary school is important. Furthermore, it is particularly important for foundation phase teachers, as they will have to teach mathematics and lay a mathematics foundation for their learners. Thus, it becomes increasingly important for student teachers to develop mathematical proficiency through their university content and methodology modules. Despite the fact, that many student teachers enter into initial teacher education programmes with varied prior mathematical achievement (Laschke, 2013) it is imperative for university courses to aim to address student teachers gaps in knowledge in order to ensure that students will be able to teach mathematics properly.

The development of mathematical content knowledge for prospective mathematics teachers in the primary school is important because primary school mathematics teaching often influences learner's attitude towards mathematics. Cobb (1986) argues that beliefs are an important aspect of making meaning in mathematics. The ability to make meaning in mathematics is strongly associated with the mathematics instruction or how it was taught. Through a combination of the mathematics content and the pedagogy, we then formulate our beliefs towards the subject. Student teachers who experienced difficulty with mathematics in the primary school are more likely to present with weaker mathematical content knowledge. Likewise, student teachers with higher mathematical prior knowledge are more likely to perform better at university (Laschke, 2013).

Working with an understanding, that solid mathematics content knowledge is essential to developing good primary school mathematics teachers. Understanding that students may come from a weak mathematics basis from school or may have mathematical literacy, some universities have looked for ways to support first year student teachers. One study at the University of Johannesburg by Fonseca and Petersen (2015) examined first year student teacher's mathematics common content knowledge in combination with a community partner, Numeric. Fonseca and Petersen (2015) tested 108 first student teacher's mathematic knowledge three weeks into their studies on mathematical content knowledge at grades 4-7 levels. Data was gathered through a baseline test. The purpose of developing baseline tests such as this one as well as those currently being developed by the Primary Teacher Education (PrimTEd 2017) research group can serve as a diagnostic tool to assess incoming student teachers mathematical content knowledge. The results of the baseline test can inform the kind of intervention students require and highlight areas where students show poor MCK.

In Fonseca and Petersen's (2015) study the baseline tested student teacher's mathematics content knowledge. The results of the baseline test indicated an average score of 37% in the sample of 108 student teachers. This implied that first year student teachers did not have conceptual understanding of mathematics concepts at a grade 4-7 level. These findings prompted the need for an intervention programme to assist student teachers improve their mathematics content knowledge. Thereafter, students had an online intervention programme based on exercises hosted on the Khan Academy platform for a period of 10 weeks. Students were required to engage with 150 hours exercises after which they were re-tested. The outcome of the endline test indicated an average score of 51%. The implications of this study show that it is possible for students to make considerable gains in their mathematical content knowledge. It was not at the level required for first-year teacher education students. My concern is that if students mathematical content knowledge is superficial (Hill, Rowen & Loewenberg-Ball, 2005) then it limits their ability to develop mathematical PCK because they lack the adequate content knowledge.

Poor mathematical content as prior knowledge for student teachers is not unique to the South African context. International studies also indicate that student teachers enter initial teacher education programmes with poor mathematical content knowledge. One such Australian study by Mays (2005) assessed first year student teacher's prior mathematical content knowledge with the aim of remediating any misconceptions or errors. The sample included 159 student teachers who had to participate in a diagnostic test, which assessed mathematical concepts that had previously learned. Student teachers would only be assigned a passing grade if they achieved 80% and above. Out of the 159 students, only 17 students achieved 80% for the content test. Such findings show that poor mathematical content knowledge from high school is likely to resurface when they enter into initial teacher education programmes.

In this study, Mays (2005) also used the diagnostic test to identify the areas where student teachers had the most misconceptions and finding ways to remediate those errors and misconceptions in the mathematics content courses. Such studies are important for teacher educators in order to ascertain student teachers gaps in knowledge. Thus if student teachers do not understand mathematics content or present with a great deal of misconceptions they will not be able to teach mathematics concepts properly to learners. Schoenfeld’s (2016) regard mathematics content knowledge as one of the tenets of *Teaching for Robust Understanding* (TRU maths). This is where teachers are able to teach for conceptual and procedural understanding, which is only possible when student teachers have a deep understanding of the mathematical concepts themselves (Lannin, Webb, Chval, Arbaugh, Hicks, Taylor & Bruto, 2013).

In another Australian qualitative study by Livy and Vale (2011) about the mathematical content knowledge of first-year student teachers indicates the extent to which mathematical content knowledge is important for preparing mathematics teachers. The authors studied 297 Bachelor of Education (B Ed) students who did their first year in 2008 at Victoria University, Australia, focusing on their mathematical content knowledge through a mathematical competency test. The test was completed by students at the end of their first semester, after having completed the first mathematics course that was part of their curriculum. The responses to the test items were analysed using Cheng’s (2006) PCK framework. Their findings of the pre-test indicate that first year student teachers had difficulty in interpreting ratio scale and area questions, which were presented as sentences and required them to demonstrate multiple steps for solving the problem. These two items were problematic because only 9% (n=28) of students had correct responses. In the other items in the test, the average of their scores was 89%. This indicates that these first year student teachers have good mathematical content. This is the ideal because understanding mathematics concepts provides a basis for their content knowledge. Lowie and Jorgensen (2015) argue that such students are more likely to be competent in teaching the same content to learners. I argue that if first year student teacher can have good mathematics content knowledge from high school then there can be more focus on learning how to teach these concepts to primary school learners.

Another study by Qian and Youngs (2013) report on the data of five of the Teacher Education and Development Study-Learning to Teach Mathematics countries, namely Chinese Taipei (Taiwan), Philippines, Singapore, Spain, Switzerland and the USA. They explored whether the type of mathematics content courses, the number of these courses and the methodology courses, which students had completed had an effect on their mathematical content knowledge and their mathematical pedagogical content knowledge Qian and Youngs (2013) found that student teachers' mathematical content knowledge scores in the USA and Spain were lower compared to the students from the other three countries. This is despite the amount of mathematics content courses students had. What was significant in their analysis of these scores was that student teachers from the USA and Spain entered their mathematics courses with weaker levels of pre-mathematical knowledge from high school as compared to the mathematics knowledge of students from Singapore, Chinese Taipei and Switzerland. They found that there was a link between the student teachers' previous mathematical achievement at school and their MCK when they enter into initial teacher education programs (Qian & Young 2013). The results of this study are significant for us because it indicates that teacher educators need to decide what mathematics content should be taught and how it should be taught.

I believe that more work needs to be done at universities to address first year student teachers' mathematics gaps in knowledge. Supplementary online mathematics courses and additional support peer and group tutorials can be a useful way to remediate student teachers' misconceptions. The mathematics content courses also need to address student teachers gaps in knowledge. The methodology courses that student teachers engage in and the role of mentoring by mentor teachers are ways of developing their PCK and their MPCK (Hudson, 2010).

2.8 Mentoring student teachers

Mentoring is perhaps one of the most effective forms of support for the professional development of a beginning teacher (Hudson, 2013). In the last decades, researchers have expressed a growing need for more focus on student teacher mentoring during practice teaching – specifically in the development of student teachers' pedagogical content knowledge (Hudson & Peard, 2005). In arguing for mentoring to focus on the development of PCK, teacher educators move from an awareness that students are not always clear on how their university coursework, in particular their content knowledge can be transformed for teaching. In this section, when I use the term mentoring I refer to a professional relationship in which an experienced person or mentor assists the mentee (Hudson, 2013), in developing specific skills and knowledge that will enhance their professional and personal growth. Furthermore, mentoring can be defined as the one-on-one support to a novice or less experienced practitioner or student teachers, designed to enhance the expertise of the mentee (Hobson, Ashby, Malderez & Tomlinson, 2009). I also draw on the description of mentoring by Johnson (2003) who argues that it is a process of guiding students through a course of study, in order for them to develop competence in their teaching practice.

Experienced teachers who take on the role of mentor to student teachers during practice teaching are a foundational element of student teacher's education literature (Borko & Mayfield, 1995). Gravett & Ramsaroop (2017) specifically argue that it is during teaching practice that mentor teachers assist student teachers in bridging the gap between theory and practice. During practice teaching, student teachers have the experience of teaching in authentic classroom environments under the supervision of a mentor teacher. It is also a time when a student teacher can observe a mentor in operation with children in a classroom setting (Hudson, 2007). A mentor's effectiveness is however dependant on a number of aspects: their subject matter knowledge, their understanding of how children learn and develop, their understanding of teaching practices, their understanding of teaching pedagogies, their understanding of reflective practices in teaching and their training as mentor teachers (Hudson, 2007; Danielson, 2002; Borko & Mayfield, 1995). Based on their expertise a mentor teacher can either enhance or detract from how a student teacher learns the craft of teaching.

It is particularly within the practicum experience that the relationship between the mentor and mentee (student teacher) is formalised (Hudson, 2013). Establishing a positive mentoring relationship is not about friendship between the mentor and the mentee but rather about the mentor providing the mentee with instructional support, psychological support and assuming the role of a model (Richter, Kunter, Ludtke, Klusmann, Anders & Baumert, 2013). Psychological support involves the mentor providing emotional support to student teachers. It occurs when the mentor listens to the student teachers concerns, encourages their student's self-esteem, builds their confidence and enhances self-reliance (Hudson, 2013). A positive relationship is also established when mentor teachers become role models for student teachers. Role modelling is provided when pre-service or novice teachers observe their mentors teaching and can learn from their practice, demeanour and behaviour. In the first year of many teaching practicums, student teachers learn mainly by observing what the mentor teacher does (Danielson, 2002).

Student teachers interactions with their mentor teachers are thus based on social and professional interactions, which requires effective communication between the mentor and the mentee. Ngidi and Sibaya (2003) assert that mentoring is a social process because it cannot occur without social interactions between the mentor and the mentee, which Hudson (2013), argues is most effective when there is a positive relationship. The mentor and mentee have the responsibility to ensure that they contribute meaningfully to this relationship. The success of the mentoring relationship is also dependent on the skills and knowledge of the mentors and the mentee willingness to learn (Beutel & Spooner-Lane, 2009). Student teachers cannot learn from the mentor if they are unable to communicate effectively, if they do not trust that the mentor values their concerns and if there is no mutual respect. Here I turn to the work of Hudson (2007) who from his research with Peard (2005) investigated the role of mentor teachers in improving student teachers PCK. Hudson (2007) designed a five-factor mentoring model for mentoring mathematics student teachers, which describes the attributes essential for establishing a positive relationship between mentor teachers and the student teachers. This is critical because one of the factors for student teacher's pedagogical development occurs when they have a positive relationship with their mentors (Hudson, 2013). Desirable mentor teacher attributes include personal qualities such as: being supportive, being comfortable with talking, being an active listener and instilling positive attitudes and confidence in the mentee (Hudson, 2007). These qualities can assist in building the mentor-mentee relationship. On the flip side, Hudson (2013) argues that experienced mentor teachers want specific desirable mentee attributes such as: enthusiasm for teaching, being approachable (not just for the mentor but also with learners, staff and parents), displaying commitment to children and their learning, having the ability to reflect on constructive feedback, resilience, and taking responsibility for their learning.

Secondly, the need for a positive relationship between the mentor and mentee is important for the mentee's professional development. The mentor teacher benefits through improved teaching practice. For instance, a positive relationship between mentor and mentee can improve student teachers development of PCK (Beutel & Spooner-Lane, 2009). A positive relationship between the mentor and the mentee can ensure effective communication between them and the student teacher will learn from the practice which the mentor teacher models. Student teachers can learn professional behaviour, discipline practices, teaching methods, and in the field of mathematics, how to structure mathematics lessons and how to assess mathematics from their observations of the mentor teacher (Wang, Odell & Schwill, 2008). Here the model of Hudson is particularly useful as he makes specific recommendations for mentoring mathematics student teachers - he argues for a focus on developing conceptual understanding as part of the PCK of student teachers.

One of the critiques to the effective development of PCK during practice teaching in the literature is that mentor teachers' efforts during teaching practicums are often focused predominantly on evaluating the mentee (student teachers) ability to facilitate learning in authentic classroom environments. On the one hand, advocates hereof, such as Hobson et al, (2009) argue that the mentors role is to guide student teachers in authentic environments (such as during their practicum experience) with the aim of developing student teachers ability to teach. Leinhardt (1993) however, argues that good teaching practice should not be limited solely to the teacher's ability to plan and execute a lesson. In her view, this emphasis does not optimally lead to the development of student teacher's pedagogical content knowledge (PCK). I have seen some evidence of this in my own setting where student teachers for the four years of their teacher education, both in the university-affiliated teaching school and in work integrated learning schools, develop lesson plans, execute such lessons, and get feedback from their mentor teachers, but with a primary focus on the students' mastery of instructional skills necessary for teaching.

This is not unique in teacher education where the mentoring focus during teaching practice tends to be centred on instructional skills for teaching. This is problematic because it does not lead to student teachers understanding what informs their PCK (Hudson, 2013). According to Feiman-Nemser (2001), mentor teachers efforts should be focused on assisting student teachers in constructing their knowledge for teaching– this author developed the term *educative mentoring* to describe this process. In educative mentoring, mentor teachers provide student teachers with opportunities, which promotes their professional growth and development. These opportunities include learning how to behave professionally, learning about classroom practices and learning from their practice through reflection (Feiman-Nemser, 2001). It is in the latter two aspects, learning about classroom practices and learning from practice through reflection, that student teachers develop professionally. However, this process of learning through reflection is often not well understood by mentors who then in turn cannot assist their mentees optimally. In my view, when mentors are not clear on how to assist mentees to learn through reflection, their student teachers do not develop PCK optimally and they may be unclear on how theory (university coursework) links with practice.

I am thus arguing for mentoring practices to focus strongly on guiding student teachers in developing their PCK (Hudson & Peard, 2005). An important element of a mentors' role in the development of PCK is being able to demonstrate explicitly to student teachers their underlying thought processes – in other words, what lies behind the pedagogical choices they make when they teach. This is particularly important for mathematics teaching because mathematics is an abstract subject area. Schoenfeld and Floden (2014) suggest that teachers need to learn how to teach mathematics for robust understanding, meaning that teacher need to teach mathematics so that learners develop conceptual understanding. Mathematics mentor teachers thus need to teach in a particular way for student teachers to observe this teaching in practice and they need to make their thinking explicit for student teachers to aid the development of adequate PCK. I discuss this in more detail in the following section.

2.9 Mentoring for the development of pedagogical skills for mathematics

While one of the foremost writers in the field of mathematics (Schoenfeld, 2016) argues that pedagogical skills are important for mathematics teaching. Student teachers can learn pedagogical skills effectively through the process of mentoring. The aim of mentoring student teachers to teach mathematics should be the development of their PCK, this does not always happen in practice. For instance in Australia, Hudson (2009) examined the effectiveness of mentoring for improving student teachers' mathematics pedagogical knowledge using both qualitative and quantitative approaches to explore mentors and student teachers' perceptions. Quantitative data was collected through a survey instrument called Mentoring for Effective Mathematics Teaching (MEMT) with a sample of 147 student teachers in their final year of study. The survey was adapted from the Mentoring for Effective Primary Science Teaching (MEPST) by Hudson (2007) and Hudson and Skamp (2003). The items in the MEMT (2009) survey were adapted from Hudson's (2007) Five factor model for mentoring mathematics, consisting of five factors for mentoring namely: personal attributes, systems requirements, pedagogical knowledge, modelling and feedback. Data from the MEMT (2009) comprised student teachers' perceptions of mentoring. The following factors: personal attributes, systems requirements, pedagogical knowledge, modelling and feedback, had Cronbach alpha scores of α=93, α=81, α=95, α=91, and α=91 (Hudson, Usak & Savran-Genser, 2009). Pedagogical knowledge had the highest Cronbach alpha score and could indicate that student teachers benefit the most from mentoring which is aimed at improving their PCK.

Qualitative analyse of these items in the MEMT survey show that for personal attributes 89% of student teachers indicated that their mentors were supportive of how they teach mathematics. Only 50% of student teachers felt that their mentors discussed general educational aims of the mathematical content areas and how to interpret policies for mathematics teaching. In addition, 85% of student teachers also had strong sense that their mentor teachers modelled the teaching of mathematics in the primary school. Furthermore, 82% of students indicated that their mentor teachers provided adequate feedback of their lesson presentations. Only 63% of student teachers indicating that their mentors provided extensive feedback about how they taught the mathematical concept and how they can review their teaching methods to improve how they taught the concept. The most valuable finding for me from this study, was how mentoring was an effective tool for improving pedagogical knowledge. This is because the essence of teaching is to improve how student teachers teach and in this particular study 77% of student teachers strongly felt that mentoring improved how they plan for lessons, provided guided preparation, assisted with teaching strategies, assisted with problem solving and implementing what is on a lesson plan into an actual lesson. From the research in this paper, I have learnt that mentoring needs to be explicit and the mentor must be intentional in explaining their thinking to student teachers. In doing so, the process of mentoring becomes more thorough and is not left to chance. In this respect I find support in in the writing of Bird and Hudson (2015) who argue that in mentoring process that are left to chance, the development of pedagogical content knowledge suffers. PCK does not develop haphazardly but is facilitated through systematic efforts, which are aimed at making the mentor teacher's thinking visible to student teachers (Collins, Brown & Holum, 1991).

There is also a view that mentoring over longer periods can be more beneficial for the development of PCK in student teachers (Spelling, 2007). Spelling (2007) furthermore suggests that longitudinal studies could provide insights into how student teachers develop and understand the practice of teaching. One such study (Rusznyak, 2014) conducted with a cohort of students over the period 2008 – 2011 at the University of the Witwatersrand (WITS) in South Africa, focused on the role of mentoring in the development of conceptual understanding of teaching practices for mathematics teaching using a pre-test and post-test design. Additional data collection methods included lesson evaluation reports, which consisted of checklists including questions about mentoring and how mentoring guides student teachers in improving their PCK. The study's sample consisted of 66 students training to be mathematics teachers for grades 7-9. Data was gathered in the form of a pre-test in students' first year and a post-test served as a baseline assessment to assess student teacher's conceptual knowledge of teaching mathematics. Over the course of four years, 893 lesson evaluation reports from mentor teachers and 406 completed checklists were part of the data. The lesson evaluation reports were the lesson plans students planned and taught and their mentor teachers evaluated student teachers.

What Rusznyak (2014) found was that the mathematics lessons taught by student teachers, with the guidance of their mentor teacher and university tutors, served to guide student teachers in the teaching of mathematics. Although Rusznyak (2014) found that the instruments were focused more on assessing teaching competence and did not allow for sufficient reflection, the role of the mentor teacher was fundamental in assisting students understanding of what they were doing, what they were not doing and what they should be doing in order to teach more effectively. The output of the post-test indicated that student teachers had gained better conceptual understanding of teaching mathematics through mentoring from their mentor teachers and university tutors.

From this research, and from my own experience in a university-affiliated teaching school, I have learnt that the feedback provided to student teachers by their mentors is valuable for developing their understanding of teaching mathematics. Mentoring can serve as an effective tool for developing student teacher's conceptual understanding of teaching mathematics and their PCK (Hudson, 2007). Pre-test, post-test designs are also important for evaluating improvements in how students understand mathematics-teaching practices because of the mentoring they have received. Longitudinal studies on the effects of mentoring mathematics in teacher education programmes can provide more insights into how student teachers develop pedagogical content knowledge (PCK) in mathematics teaching and become more critically reflective practitioners.

2.10 Reflective practice for developing mathematics pedagogical content knowledge (PCK)

Reflection is one of the aspects of mentoring which mentor teachers use in order to help students develop their pedagogical content knowledge (PCK) and needs to be taught explicitly. However, in order to teach students to be reflective mentor teachers need to be critically reflective themselves (Danielson, 2002). The roots of reflective teaching are historically evident in the work of John Dewey (1938) who maintained that reflection is an important aspect of learning from experience. Reflective practice in teaching is an important part of the practicum experiences of student teachers. Dewey (1904) makes the distinction between two kinds of practice work: apprenticeship practice work and laboratory practice work. The focus of apprenticeship is on student teachers gaining practical skills, which they require for teaching. These can be learnt from the mentor teacher through observations, repetition of tasks and classroom management. Practice work with an apprenticeship focus is valuable to all stakeholders in teacher education programmes because the results of such work are observable to the stakeholders (Dewey, 1904:13).

On the other hand, Dewey (1904) describes laboratory practice as a mentoring process focused on developing teachers who think about their practice (which can include apprenticeship practice work). In laboratory practice work, a mentor can analyse the student teachers' observations and pedagogic choices in order to help student teachers to understand what theoretical lens informs their teaching practice. Dewey (1904) indicated that laboratory practice work is aimed at provoking 'intellectual reactions' which are about thinking about providing logical and academic reasons for the practice one engages in. Reflection in a laboratory classroom environment enables both the mentor and the student teachers to learn and understand how their theoretical lens informs their choice of teaching methods. Mentor teachers in this regard are able to explain to student teachers what informs their pedagogy.

In a teaching practicum in a teaching school setting, there is a greater possibility for laboratory learning during teaching practice because mentor teachers can experiment with different pedagogies (Gravett, Petersen & Petker, 2014). The memorandum of agreement (MOU) with the department of basic education regards the teaching school as a unique institution designed to experiment with the curriculum and model best teaching practices. Gravett and Ramsaroop (2017), concur with the notion of a teaching school as a teacher education laboratory.

The teaching practicum is the ideal environment in which a mentor and student teachers can engage in reflective practice because reflection cannot happen in isolation from teaching. Korthagen (2004) describes reflective practice as meta-cognition, which means thinking about how one thinks about ones teaching. Shandomo (2010) further refers to reflection as a process of self-evaluation in which educators regularly engage in to improve their professional practice. Reflective thinking leads educators to ‘act deliberately and intentionally rather than randomly and reactively’ (Shandomo, 2010: 4). Mentor teachers have the responsibility to ensure that they understand the various processes involved in reflective practice. These reflective processes should/ could then be used in guiding student teachers in developing the processes of reflection. This starts with the mentor teacher being critically reflective themselves (Harrison, Lawson & Wortley, 2005). Reflective mentors think about their own teaching and how to improve how they teach. To elaborate on this, I turn to the work of Schon (1993) whose model for reflection provides a useful framework for understanding the process of reflection during teaching. Schon’s model highlights three criteria, namely: 3) reflection *for* action, 1) reflection *in* action and 2) reflection *on* action. I will discuss each of these using the example of mathematics as subject area/ discipline.

In reflection *for* action (Schon, 1993) refers to aspects that should be considered in planning for a mathematics lesson/s. Here a mentor/s would ideally show a student how they think about and articulate their lesson aims and objectives, the structure of the lesson, what the teaching methods are and what informs these, the resources they need, how to use knowledge of the learners needs and context, and what learners’ prior knowledge is. Richter et al (2013) also refers to this as instructional knowledge for teaching. Then, during the actual teaching episode, mentor teachers need to provide an account of the change they implemented – this is referred to as reflection *in* action - explicitly to student teachers. This type of reflection refers to the ability to think and change methods or pedagogies in the moment when they are not working (Schon, 1993).

Reflection *in* action does not mean that the teacher stops teaching a concept but rather finds a new way to teach the concept while the lesson is still in progress. For inexperienced student teachers, this is perhaps by far the most difficult aspect of reflection to learn. Student teachers do not usually have a ready stock of multiple methods at their disposal and are likely to be stumped if one method does not work. In addition, if students have a limited understanding of the teaching methods they can use, it becomes difficult for them to think of how they can improve on this aspect of their teaching. However, an experienced teacher, who has many methods of teaching at their disposal, this is usually not a problem.

Reflection *on* action is about the reflection teachers engage in at the end of the lesson (Schon, 1993). The main focus here is to think about what went well and what was not a success. The mentor has a role to specifically-help the student teacher reflect on their PCK and how they can refine their teaching methods for teaching a particular concept. Mentor teachers need to help student teachers articulate the thinking, which informed their pedagogies (Collins, Brown & Holum, 1991). This kind of reflective practice is 'hidden' or consists of obscured elements about the lesson can be brought to the surface for discussion and clarification. For instance, the mentor teacher can help the student by reflecting on their pedagogies according to the various phases of the lesson. For instance, in the introduction a student teacher may not have fully elicited learner's prior knowledge before teaching about the adding of three digit numbers. A mentor teacher could then advise the student to use mental maths activities of adding two digit numbers to elicit learner's prior knowledge.

2.11 Conclusion

In conclusion, the literature shows that there is a great need for a more explicit type of mentoring that makes the mentor teachers' thinking visible for student teachers (Collins et al, 1991). Mentor teachers can contribute immensely to the development of student teachers PCK (Shulman, 1987) through structured mentoring practices within the practicum. Initial teacher education programmes can and should equip student teachers with adequate content knowledge to ensure that student teachers can develop their pedagogical knowledge. Mathematics content knowledge has a direct relationship with a student teachers pedagogical knowledge. The combination of mathematics content knowledge and pedagogical knowledge (PCK) is the essence of teaching.

CHAPTER 3:
RESEARCH DESIGN & METHODOLOGY

3.1 Introduction

The aim of this study is to report on students and mentor teachers views of their experiences of the mentoring of mathematics teaching in the foundation phase. I thus chose as a research design for this study a generic qualitative design as described by Merriam (1998). Generic qualitative studies have a long history in educational settings and is appropriate when a researcher aims to investigate an issue from the perspective of the participants themselves. In this chapter, I will discuss my positioning as a researcher in the educational setting. In addition, I will discuss how the theoretical framework links with this particular research design. Furthermore, I will discuss the data analysis methods, the data, the collection process, ethical considerations and lastly the trustworthiness of the research (Lincoln & Guba, 1985).

3.2 Positioning myself as a researcher in an educational setting

As an educational researcher, my choice of research design is influenced by my epistemology and ontology. Creswell (2007) describes epistemology as an understanding of how knowledge is created while Gibson (2017) describes epistemology as theories about knowledge centred on what researchers know and how they gain knowledge about the world. This implies that epistemology reflects a theoretical stance of how an individual knows and understands the world. One's epistemology is also aligned with one's ontology – what we believe about the nature of reality (Gibson, 2017), which naturally also impacts on the methodology one chooses to investigate the world. There is thus a direct link between a researcher's epistemology, ontology and methodology.

There are also a number of debates around the main traditions of knowledge, also known as paradigms – the main three however are commonly recognised as the positivist, interpretivist and critical traditions (Babbie & Mouton, 2015). As an emerging social scientist, I needed to understand these and situate myself accordingly. The term 'positivism' came into prominence in the eighteenth century, as a way of describing principles on how scientific enquiry should be approached (Gibson, 2017:57). Positivist philosophies are centred on attempts to positively verify knowledge through scientific methods. It requires as process of scientific enquiry in observing the world objectively without any bias, in order to develop generalizations about what the world is like (Gibson, 2017). These generalizations become knowledge, which should then be of practical value and should contribute to improving the world. Positivist philosophies also argue that ones understanding of the world should come through ones experiences of the world (empiricism). Generally, positivism is aligned with a more objectivist tradition of research, which argues that knowledge consists of objective truth and that is it possible, through precise scientific research, to attain objective truth and meaning of any knowledge form (Gibson, 2017).

On the other hand, the paradigm of 'interpretivism' arise from a set of assumptions from diverse fields of study such as philosophy, anthropology, psychology and sociology (Gibson, 2017: 62). The interpretivist tradition describes a range of theoretical perspectives of how people interpret and give meaning to their experiences in the process of generating knowledge (Gibson, 2017; Henning, Smit & Van Rensburg, 2011). Interpretivists regard knowledge as part of a human being's perspective of the world and requires that such social scientists interpret their experiences of the world through these frames of reference. Thus although interpretivists accept that some basic reality exists, they also believe that knowledge of this reality and the reality they construct is subjective. As this is entirely a matter of perspective and personal experience, this subjectivism in research aims to produce knowledge that will lead to social change (Brophy & Good, 1986).

The third traditional paradigm is the critical theory paradigm. This paradigm is historically, founded by three leading theorists of the original Frankfurt School. Horkheimer, Adorno and Marcuse represented the first systematic attempt to refine Marxist traditions through traditional empirical research techniques (Horkheimer, 1985). Critical theory is particularly concerned with power relations within society (Horkheimer, 1985). Furthermore, critical theory addresses issues of the interaction of race, gender, class, religion, economy and other social institutions that contribute to the social system (Horkheimer, 1985). Horkheimer's (1985) definition similar to Bohman's (2005) observation suggests a criteria for an adequate critical theory. Firstly, it must be explanatory about what is wrong with current social reality. This is achieved by challenging the guiding assumptions about the current reality. Secondly, it is descriptive and provides norms for social inquiry, which is aimed at decreasing domination and increasing freedom in all their forms. Lastly, it must identify a possible action to change that social reality. Critical theorists do not just describe the situation but they attempt to change the situation. In order to effect change critical theorists must provide clear guidelines for criticizing what is wrong and implement transformation process (Bohman, 2005).

Philosophically I align myself with the research tradition of interpretivism. I believe that people make meaning of their worlds in interaction with others and that knowledge is constructed in social contexts. The idea of constructing knowledge in a social context could imply that knowledge generation does not occur isolation of a knowledgeable other (Vygotsky, 1978) nor does it mean that knowledge is passively gained. As I was interested in gaining an understanding of the process of mentoring for mathematics teaching, I wanted to investigate the phenomenon from the perspective of the two main role players in the endeavour – the student teachers and their mentors. In the model of the teaching school, mentor teachers take on a very specific role in guiding students on the methodology/ pedagogy for teaching particular subjects – they are required to guide and assist student teachers in developing their repertoire of teaching strategies. In a primary school situation where children learn all subjects there would of course be general pedagogical techniques that would be emphasised but I was particularly interested in how this manifest in the subject area of mathematics teaching (Danielson, 2002). Situating myself epistemologically and ontologically in a particular paradigm or tradition of research enabled me to clarify my methodological choices. As I believe that people in interaction with each other make knowledge, and as I was interested in the process of mentoring for mathematics in a teaching situation, I needed to find this out from the people involved in this endeavour. I thus set the following research question:

What are student teacher's and their mentors' views of the process of mentoring for mathematics teaching in the foundation phase?

This research question directed the aim of my study, informed my research design and also informed the choice of methods for data generation and analysis. In this process, I thus employed a particular research design.

3.3 Designing a study to investigate the mentoring of mathematics in the foundation phase

In the choice of research design, Merriam (1998), Henning, Van Rensburg & Smit (2004) and Maykut & Morehouse (1994) led me to the use of a qualitative research design. Generic qualitative studies are one of a number of qualitative research designs comprising of case studies, ethnographies, action research, participatory action research, narrative enquiry and design-based research (Swain, 2017). These methodologies are unique to qualitative research because of their explanatory and descriptive characteristics.

A generic qualitative study design is commonly used in the field of education, and draws from concepts, models and theories in educational development. As the investigation takes place in an educational setting, a 'teaching school', and captures participants views of a part of the developmental process of mentoring for mathematics teaching, I was of the view that a generic qualitative research design best fit the problem I was investigating.

Qualitative research in general is primarily exploratory research. It is used to gain an understanding of underlying reasons, to try and explain the occurrence of the phenomenon (Henning, van Rensburg & Smit, 2011). Explanatory research focuses on asking why a phenomenon occurs and seeks to describe the underlying reasons (Henning et al, 2011). This approach to research aims to provide insights as to why the phenomenon occurs and is also used to uncover trends in the thoughts and opinions of the participants and gain better insight of the problem. Qualitative researchers are interested in understanding people's experience in context. The natural setting is the place where the researcher is most likely to discover, or uncover, what is to be known about the phenomenon of interest (Maykut & Morehouse, 1994). In line with this type of design, the data generation methods vary. The data collected in qualitative research is often people's words and actions and requires methods, which capture how people behave and use language to articulate their thoughts? Qualitative research designs consist of various methodologies such as a generic qualitative study, case study, ethnography, action research, participatory action research, narrative inquiry and design based research (Swain, 2017). These methodologies unique to qualitative research because of the explanatory and descriptive characteristics.

Generic qualitative studies are also naturalistic studies or studies, which occur in natural contexts; in addition, the phenomenon is studied in its natural settings (Lincoln & Guba, 1985). This kind of methodology is interpretive and focuses on gaining insights and understanding the way people make sense of their experiences (Merriam, 1998). It allows the researcher the flexible in using a variety of qualitative data collection and analysis tools to describe, interpret the findings expressed in the themes gathered from the data. (Gravett, 2006 & Lincoln & Guba, 1985). Generic qualitative studies are inductive and meaning is inferred from the data collected. From this type of methodology data collection methods include observations, individual interviews, focus group interviews and the collection of relevant documents (Maykut & Morehouse, 1994: 55).

A study's research design and its theoretical framework are closely linked. In discussing how a case study is best suited for this study, I refer to Schoenfeld's (2016) theoretical framework on mathematics teaching called Teaching for robust Understanding (TRU Maths) as a framework for elaborating on the choice of design, which is a case study. This framework provides a theoretical lens for approaching mathematics lesson planning. The domains in this framework are discussed in chapter 2. This framework links with a generic qualitative design because the participants are studied in their natural context of teaching and learning. The TRU Maths framework is an appropriate lens for understanding teachers' and student teachers' mathematical PCK development through lesson planning in the foundation phase.

3.4 Data collection methods

Commonly-used data collection methods in qualitative studies include focus group interviews, individual interviews, and observations (Collins, Scanlon & Shea, 1992) and can also include participant observations (Wolcott, 2001). These qualitative data collection strategies allow the researcher to gather first-hand knowledge about the phenomenon in its natural environment (Wolcott, 2001). Collecting data in this way allows the researcher to get a real sense of the experiences of the participants involved in the study.

In choosing data collection methods for this study, I was guided by my overall research orientation, the design of the study and the research question I posed. Informed by the work of Creswell (2007), I worked with the view of data collection as a "series of interrelated activities” (Creswell, 2007:146) aimed at gathering good information to answer my research question. As I aimed to get an understanding of the process from the perspective of the participants themselves, namely the students and the mentors, the data in this study was collected through focus group interviews with student teachers and individual interviews with mentor teachers.

3.5 Sampling: purposely choosing participants

The sampling criteria was be purposeful for this study. This means that the researcher selects participants because they can inform or contribute meaningfully to addressing the research problem and they are central to the phenomenon (Creswell, 2007). In the context of this study, I have selected two grade 2 teachers and one grade 3 teacher. These teachers are responsible for teaching all subject areas in the foundation phase. Grade 2 in particular serves as an important transition between the first year of formal schooling (grade 1) and the last year of the foundation phase (grade 3). Furthermore, a grade 3 mentor teacher was selected for the pilot study. All the mentor teachers who participated in this study teach at the university’s teaching school.

From my experience as a school teacher I have found that learners who experience learning difficulties in mathematics and in their home language are most likely retained in grade 2 because concepts can be remediated before the learner is in grade 3. Thus, the teacher’s PCK for teaching grade 2 learners is important. As this particular grade bridges the gap between the beginning of formal school and the exit grade in the foundation phase. In this grade, student teachers should be developing a greater depth and understanding of the kinds of teaching methods they utilize and understand how these improve their own teaching of mathematics and other subject areas. For student teachers I focused in on those in the third year of study (in a foundation phase teacher education programme), choosing student teachers from both language groups within the school. Six student teachers that observe in the Sesotho classroom were selected and another six students from the IsiZulu classroom were selected purposely. I reasoned that third year student teachers in the teaching school could speak knowledgeably about their experiences.

3.6 Interviews as data collection method-focus and individual interviews

Social scientists use interviews to gain an understanding of the views of participants on a particular topic from the perspective of the participants themselves. In choosing focus group interviews for the student teachers, I wanted to gain an understanding from them (in interaction with others in the group) of their experiences of the mentoring they receive from mentors. Focus group interviews are qualitative in nature and can be described as interviews, which consist of a group of people (Creswell, 2007). Asking for their responses in a group format kept consistency with their overall practices in their studies as they plan and teach their lessons at the teaching school in practicum groups. Part of the mentoring sessions thereafter includes peer evaluations within the group with students being provided with the opportunity to reflect as a collective. It was thus important that I maintain this cohesive format in the research process – I reasoned that group feedback from students would present a continuation of this process. The groups of students selected were from both the isiZulu and Sesotho classes at the teaching school as I wanted to get as wide a view of student teacher's experiences in the school as possible, with more than one mentor teacher. This view was informed by Danielson (2002) who argues that student teacher's experiences differ during their practicum because mentor teachers employ different strategies for teaching.

On the other hand, I chose to use individual, semi-structured interviews with the two grade 2 mentor teachers. I chose individual interviews as I wanted to get each teachers views without them interacting or leading from each other's points. Individual interviews allowed me to ask set questions but also enabled reasonable flexibility for probing - asking questions closely related to the prescribed questions, if the responses are vague or lack clarity (Creswell, 2007). I reasoned that through individual interviews I could begin to understand teachers' experiences or understanding of mentoring of mathematics. I was also particularly interested to understand if (and how) mentor teachers emphasise mathematical thinking in the process of mentoring.

3.7 Conducting a pilot: learning from my mistakes

Beginner researchers are encouraged to undertake pilots for number of reasons: Pilot studies are a crucial element of a good research design (Hassan, 2006). The researcher can test and investigate the study on a smaller scale and refine any areas that needs to change (Hassan, 2006). Pilots also help the researcher determine the feasibility of the study by testing elements of the study. In this particular context, the interview questions in the pilot study were amended after the pilot. Accordingly, I conducted a pilot interview with a mentor teacher at the teaching school. This pilot interview taught me that it is important to probe the participants when you feel like they are not responding adequately to the question. In addition, the pilot led me to refining or changing some the questions I asked and also revising the sequencing of my questions. I also learnt that some of my questions needed to be changed in order to channel the discussion on mathematics teaching to focus on teacher's current PCK. This includes more discussions around how teachers teach explicitly and discussions about how they develop conceptual understanding of mathematical concepts in foundation phase learners. Furthermore, how mentor teachers teach or impart those teaching methods to student teachers.

3.8 Data analysis methods

In keeping with the exploratory and open-ended nature of the process of data collection, I also opted for a similar process of data analysis, guided by my knowledge of the topic and the reading I had done in chapter 2. In particular I was guided by the theoretical frame of Schoenfeld (2016) who suggests a mathematical tool 'Teaching for Robust Understanding' (TRU Maths) which can be incorporated in lesson planning, to address how mathematical processes are taught in mathematics teaching, in the process of developing mathematical thinking.

In this stage of the study, data is analysed and interpreted in order to make sense of it (Henning et al, 2011) and I adopted an interpretivist stance. An interpretivist view is concerned with understanding the phenomenon as it is from the experiences of the participants and in order to understand why the phenomenon occurred (Henning et al, 2011). The unit of analysis of this study is student's and their mentors views of the processes of mentoring for mathematics teaching.

In the initial discovery process, I made use of the Look/Feel alike method by Maykut and Morehouse (1994). This method is about uncovering salient aspects in one's data (Maykut & Morehouse, 1994). This includes identifying recurring and salient points such as phrases or words, which are represented on a discovery sheet. Following that, I used the *Constant Comparative Method* (Glaser & Strauss, 1967) as an overarching framework for analysing the data. This method provides a systematic approach to data analysis in the following ways: Firstly, the raw data is coded to source by creating units of meaning, which best describe the participant's responses in order to create provisional categories. Secondly, the provisional categories are analysed by comparing the units they are formed from in order to create categories. Thirdly, the relationships between all the categories are explored in order to refine the categories. The forth step in this method is about developing themes, which are discussed as the findings in the study.

3.9 Validity and reliability

In scientific investigations, issues of validity and reliability are vital. Validity and reliability in qualitative research are often referred to as the quality, rigor or trustworthiness of the research (Simon, 2011). Lincoln and Guba (1985) first raised the issue of rigor in their descriptions about the trustworthiness of qualitative research. They argue that trustworthiness refers to quality, authenticity, and truthfulness of findings of qualitative research (Lincoln, 1995), in other words it asks to what extent readers will have trust, or confidence in the results of the study. Trustworthiness can be addressed through the following four measures:

Credibility – this is about the extent to which the researcher is confident that findings in the study are true and accurate. In order to verify that the data is credible, qualitative researchers often employ a method called triangulation. Triangulation rests upon the belief that a single method of data collection can never adequately explain a phenomenon (Lincoln, 1995) Using multiple methods can help to facilitate a deeper understanding of the findings and data (Allen & Oliver-Hoyo, 2006). In this study, I was able to get the perspectives of both the mentor teachers and the student teachers to triangulate the data.

The second, transferability, is how the researcher demonstrates that the findings in the study are applicable to other contexts. In qualitative research, this can be achieved through providing a rich, thick description (Merriam, 1998) so that a reader is in a position to judge to what extent the findings in the study are relevant and applicable to other contexts (Simon, 2011). In this research, I provided detailed discussions of both the content of the research and the steps in the analysis to enable other researchers to judge the applicability of my findings to their own work.

Confirmability is the extent of neutrality in the research. This means that the findings are based on the participant's responses and that bias from the researcher/s is limited. This includes ensuring that the researcher's thoughts, opinions or bias does not skew the data (Allen & Oliver-Hoyo, 2006). To establish confirmability, the researcher should be able to provide an audit trail, which highlights every step of data analysis that was made in order to provide a rationale for the discussions in the study (Allen & Oliver-Hoyo, 2006). Interview transcripts can also be audited to ensure that the findings are truly reflective of the participant's responses. To this end, Shenton (2004) believes that the decisions underpinning the researchers' methods should be acknowledged within the research report. I have done this by detailing the steps I took in the process of the research, providing ample examples of my workings so that the reader can judge the confirmability of the findings.

The last, dependability is the extent to which other researchers could repeat the study and that the findings would be consistent (Shenton, 2004). Put very simply, if a person wanted to replicate a study, they should have enough information to do so and obtain similar findings as the original. A qualitative researcher can use inquiry audit or peer evaluation in order to establish dependability – this will require an outside person to review and examine the research process and the data analysis in order to ensure that the findings are consistent and can be repeated (Shenton, 2004). I have provided both contextual and analytical detail for the reader to ascertain the dependability of my results.

3.10 Ethical considerations

This study was planned so that participants would not be harmed. All the participants in the study are voluntary participants and were not coerced in any way to participate. However, as both the teachers and students are part of a university programme, I had to bear in mind that they might have felt obligated to partake in this study because of their affiliation with the institution and because of my relationship with them. In order to put them at ease they were encouraged to share any discomfort with me and were also informed that they could withdraw from the process at any time without any repercussions. In my deliberations with the students and teachers, I tried to be sensitive to picking up any signs of discomfort.

Before I started this investigation, I applied for ethical clearance to conduct my study. The process of getting ethical clearance begins with applying for consent with the coordinating body that governs research at the teaching school. Following this process, an ethics application is submitted to the ethics board in the faculty for approval to conduct the study. This study was approved and allocated the following ethics clearance number: *2018-024*. A second issue was that of anonymity. Although pseudonyms are used, participants are identifiable from the setting and the descriptions in the dissertation. Given the uniqueness of the setting, it would thus be easy to identify individuals, which would nullify the guarantee of anonymity. This was explained to the participants who were comfortable proceeding. I also allocated pseudonyms when referring to the participants during the discussions in both the focus group and individual interviews.

The following principles provide ethical and culturally neutral approach to ethical issues when involved in research. These principles include respect for autonomy, non-maleficence, beneficence and justice. I will briefly discuss how these principles are incorporated in the study.

- As a researcher, it is important for me to respect the autonomy of my participants. Autonomy refers to the participants' capacity to think, decide and act on their own thoughts (Townsend, 2010). Participants were not coerced to participate or express views, which they do not believe in.
- Beneficence is a research ethics principle where the researcher should consider the well-being of the participant during the process of collecting data (van der Reyden, 2008). Furthermore, beneficence can also be described as the researcher's actions, which promote good practices in the study. This means that what is being researched and how the research is conducted should benefit both the researcher and the participants. I ensured that my participants benefit from the study by helping them reflect on their PCK during the data collection phase.
- The next research ethics principle refers to non-maleficence, which is means that the research or study should not cause harm to the participants. Furthermore, this research principle is about not avoiding any risk of harming the participants (Townsend, 2010). In this study, the participants are not vulnerable in terms of their age however; no intentional harm was caused during the interviews.

- The last ethics principle refers to justice. This principle is concerned with how the benefits or burdens of the participants need to be distributed fairly and equitably in the study (van der Reyden, 2008).

3.11 Conclusion

In this chapter I discussed how my positioning in research in the educational context. In addition, I discussed how my theoretical framework is aligned to the research design. Furthermore, I discussed the data collection methods, the trustworthiness of the data and the ethical considerations. In the next chapter, I provide a detailed description of the data analysis process. In order to achieve this I describe a data analysis method, which leads to the development of themes for the discussion.

CHAPTER 4:
THE ANALYSIS OF DATA

4.1 Introduction

This chapter consists of the presentation of data that was collected in the course of the study. Using data collection techniques such as individual interviews with mentor teachers and focus group interviews with student teachers, data was gathered in an attempt to answer the research question and meet the aim of this particular study. To analyse my data, I drew primarily on the work of Maykut and Morehouse (1994) as an analytical tool.

In qualitative research people's words or actions are examined in a narrative or descriptive ways to understand the meaning of events and to represent their experiences as closely as possible (Patton, 1991; Maykut & Morehouse, 1994). One of the distinctive features of qualitative research is an inductive approach to data analysis, where meaning is derived from the data set (Lincoln & Guba, 1985), through a process of coding and categorizing of the data. Patterns emerging from the categories will all then be consolidated to form themes that form the basis of the findings thereof.

In the following sections, I discuss how I used the constant comparative method (Glaser & Strauss, 1967) as an over-arching framework to analyse the data. This will include analysing the data according to the steps specified in the method to make sense of the data. I describe how the data from the interviews was transcribed and coded to create units of meaning. Then I discuss the formation of provisional categories and lastly the refined categories and how patterns were found in the data.

4.2 Using the constant comparative method of data analysis

In the rest of this chapter, I will show how I used the constant comparative method of analysis with the data generated through the interviews with mentors and students. I provide examples and extracts to show how I worked with my data to arrive at the results. The constant comparative method of analysing qualitative data thus consists of a process of inductive category coding and comparing the codes or units of meaning with other codes (Glaser & Strauss, 1967). This is a crucial step to creating provisional categories, which emerge from the smaller units of meaning. The provisional categories are then refined into themes which will be useful for the discussion and findings. The following diagram is an adaptation of by Glaser and Strauss (1967) and provides a flow diagram of how the Constant Comparative method is used for qualitative data analysis.

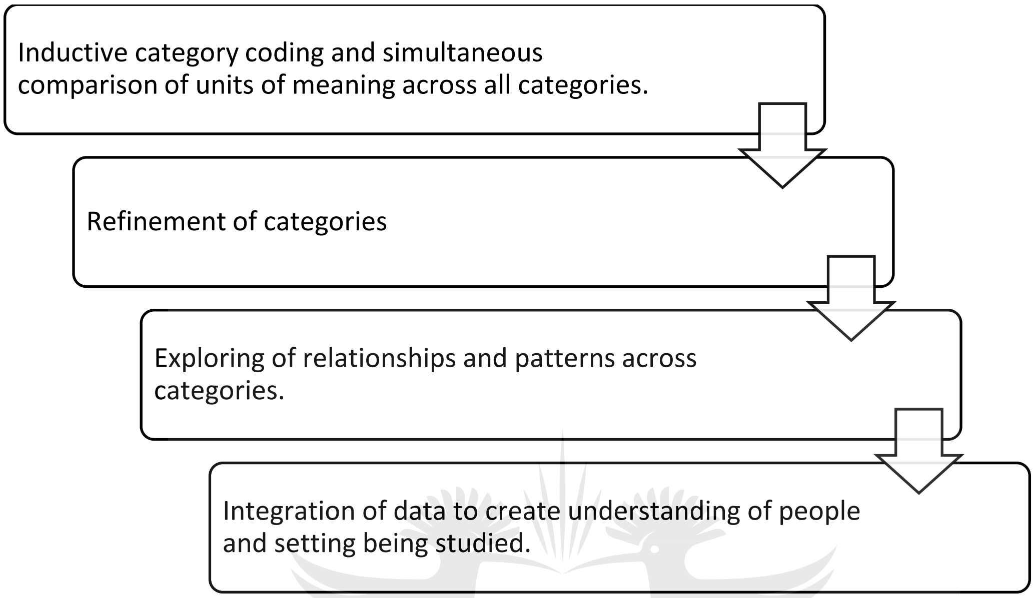


Figure 4.2.1 The Constant Comparative Method for data analysis (Glaser & Strauss, 1967)

Before providing the examples, I first give some detail of the different data types.

4.3 Interview schedule and demographics: mentor teachers

As already indicated in chapter three, all the mentor teachers are mentors to student teachers at the teaching school in the foundation phase. The teachers general experience of foundation phase teaching ranges from seven to twelve years teaching in the foundation phase with the collective experience begin between five-six years. The demographics of mentor teachers are important for understanding the number of years the teachers have been mentor teachers and whether or not their experience influences their mentoring practice. Table 4.3.1 shows the demographics of the mentor teachers who participated in the interviews.

Table 4.3.1 Mentor teacher's demographics

Mentor teacher	Grade teaching	Total years of teaching experience	Number of years teaching at the teaching school	Ethnicity	Gender	Highest qualification
MT1	1	7	6	African	Female	Honours
MT2	2	7	5	African	Female	Honours
MT3 (HOD)	3	12	6	African	Female	Masters

4.3.1 Interview questions for mentor teachers

I used the following questions to elicit the mentor teachers understanding of mathematics teaching and mentoring of student teachers.

1. What do you think student teachers need to know in order to teach mathematics effectively?
2. Having observed student teachers teaching in the grade 3 classes, can you give us your impression of the approaches they use? Are there any specific methods you encourage students to use? How do you assist them during your mentoring?
3. What is the nature of their reflection after the lesson presentation? How do you guide them in this?
4. Is there anything else you would like to share regarding mathematics teaching and mentoring?

The details of the interviews with the teachers is captured in Table 4.3.1.1 below.

Table 4.3.1.1 Details of the interviews with the mentors

Mentor teacher	Date of interview	Duration of interview	Venue
MT1	2nd August 2018	Approximately 10-15minutes	Mentor's classroom
MT2	2nd August 2018		Mentor's classroom
MT3	31st August 2018		Mentor's classroom

4.3.2 Interview schedule and demographics: student teachers

Likewise when working with the student teachers it was important to understand their experiences regarding mentoring and find out what they understood about mathematics teaching. Here I used focus groups interviews and each focus group consisted of six third year students who observed in the Sesotho grade 2 or IsiZulu grade 2 classes. It was important to get students from both classrooms to gain better insights of student teacher's experiences from both groups. Table 4.3.2.1. shows the demographics of student teachers.

Table 4.3.2.1 Demographics of student teachers and interview details

Student	Ethnicity	Age	Gender	Duration of interview
Focus Group 1				
Student 1	African	18-25	Male	Approximately 10-15 minutes
Student 2	African	18-25	Female	
Student 3	African	18-25	Female	
Student 4	African	18-25	Female	
Student 5	White	18-25	Female	
Student 6	African	18-25	Male	
Focus Group 2				
Student 7	African	18-25	Female	Approximately 10-15 minutes
Student 8	Coloured	18-25	Male	
Student 9	African	18-25	Female	
Student 10	African	18-25	Female	
Student 11	African	18-25	Female	
Student 12	African	18-25	Male	

The following interview schedule was used to guide the students in sharing their responses regarding mentoring in the teaching school.

4.3.3 Focus group interview questions

1. What do you consider important for mathematics teaching in the foundation phase classroom?
2. What are the methods you generally use to teach mathematics? What content goes together with these methods?

3. How does your mentor teacher guide you in the methods you will use for teaching mathematics?
4. How does the mentor teacher help in the mentoring session after you have taught the lesson?
5. Is there anything else regarding mathematics teaching and mentoring you would like to share?

4.4 Preparing the data for analysis

In starting the analysis process, I had to first prepare the data. Individual interviews recordings with the mentor teachers and the interview recordings with student teachers were transcribed verbatim. The transcripts were in English as most of mentors answered the questions in English. Some of them answered the questions in IsiZulu and these portions of the data were then translated into English to enable the analysis process and to provide an audit trail. The interviews with the mentors were all conducted at the teaching school in the teachers' classrooms. Similarly with the focus group interviews were transcribed verbatim and where students code-switched used IsiZulu, the sections of the transcripts were translated to English.

4.5 Coding the data to source – labelling the data sets for analysis

I started by analysing my data by first coding to source (Maykut & Morehouse 1994). This was done by naming the type of data, the page numbers and creating codes to identify each data set. At the end of this process, I had five data sets for analysis – three of teacher interviews and two of student focus group interviews.

4.5.1 The initial discovery process

I started the actual data analysis process by reading the transcripts a number of times and thinking about important ideas, recurring phrases, topics from the data – these ideas I recorded on a sheet of paper. Maykut and Morehouse (1994) regard this as the discovery process, which they argue is a first step at uncovering salient aspects in one's data (Maykut & Morehouse, 1994: 122). It is also a process, which could enhance the analysis and coding of the data. Likewise, it is also important to consider important ideas, which were not evident in the data. This kind of analysis is important for the discussion on the findings. Below are some important ideas that came up many times in my reading of the data.

4.5.2 Discovery Sheet

- Mentoring
- Content knowledge
- Teaching methods
- Reflection
- Teaching aids
- Participation in learning
- Attitudes towards mentoring
- WIL and Funda practicum

4.6 Coding the data – making sense of the meaning of interviews

After compiling my discovery sheet, I began to unitize the data. The process of unitizing data in qualitative data analysis involves identifying "units of meaning" in the data transcript. A unit of meaning is a piece of information in the data that can stand on its own with meaning. In unitizing the data, I allocated a code, which captures the essence of each unit – here I tried to stay as close to the words of the participants as possible. Units of meaning were created by reading carefully through the transcripts and extracting salient points from the participant's responses. In table 4.6.1. I provide an example of the interview codes extracted from an interview transcript with student teachers.

Table 4.6.1 Focus Group 1: allocated codes for units of meaning

Line	Interview transcript – Focus Group 1 PG 1	Codes
Line 1	***N:*** *So the first question I would like to ask you is what do you consider important about mathematics teaching?*	Content knowledge important for developing PCK
Line 2	**S1**: I think as a teacher you should know what maths is. and what it is about before you teach children.	
Line 3	You must know what you're going to teach.	
Line 4	Also know how you're going to teach because you can know maths.	Know teaching methods Know how to teach
Line 5	If you can't teach it then it's like what are you saying to children.	
Line 6	***N****: Any other responses?*	
Line 7	**S2:** As a teacher you need to identify how different learners learn mathematics.	Importance of learning styles
Line 8	So one learner can just listen to the teacher explain.	Auditory style
Line 9	When it comes to other learners, they might need practical examples.	Concrete examples
Line 10	So the teacher needs to be able to identify different learners learn.	Learning styles important in PCK
Line 11	And understand maths.	Knowing learners prior maths knowledge
Line 12	**S3:** I think it is important that the teacher knows the learner's prior knowledge.	
Line 13	Because if we as teachers don't know their prior knowledge,	
Line 14	then how will we know what we are supposed to build up on.	Making connections with new knowledge
Line 15	***N:*** *Ok. What else do you think for teaching personally you need to know for teaching maths?*	
Line 16	**S4:** To add on what she just said. Content knowledge is very important.	Importance of content knowledge

I continued in this way with each of the transcripts and once there were a number of codes allocated, I was in a position to begin the next phase. In allocating the individual codes for each unit of meaning I was clear to note the type of interview, the participant, the page number and the line it is found in the transcript – this information was important for tracing who was speaking, in what context and provided me with a means of retracing my steps to the transcripts when I was putting the various data together to make meaning. This type of information is also important for creating audit trail and ensuring that the reader can trace the data back to its source. In Table 4.6.2. In red I provide an example of this detail.

Table 4.6.2 Example of units of meaning (interview codes)

FG1/S3/PG128/L14 code/unit of meaning: Making connections of prior & new knowledge	**FG1/S4/PG128/L16** code/units of meaning: Importance of content knowledge

4.7 Using the 'look/feel-alike' method to create provisional categories

Once all the data had been unitized, I could then begin to make sense of the dominant ideas and create conceptual categories of meaning. This required me to create provisional coding categories – here I used the 'look/feel-alike' method (Maykut & Morehouse, 1994; Lincoln & Guba, 1985) as a way of describing the developing process of categorizing qualitative data. Thereafter, codes are compared to other codes and grouped into provisional categories with a similar meaning. In this a "rule of inclusion" is useful – a rule of inclusion is a statement that describes the properties of the provisional categories and informs how the units of meaning fit together. All the data is clustered in a similar way and if there are no similar codes, then a new category is formed. Working in this way enables a researcher to continuously refine, change, merge and create new categories. (Goertz & LeCompte, 1981). I worked with hard copies and physically cut up the individual units of meaning – as a beginner researcher I felt that this gave me greater flexibility and control of the process as I was working to make sense of the data. I then constructed mind maps in which I clustered individual codes to form provisional coding categories. I include photographs of these as examples for the reader in my explanation of each provisional coding category (mind maps labelled 4.7.1.1 to 4.7.9.1).

4.7.1 Provisional category 1: The value of exposure to different mentor teachers during the practicum

Rule of inclusion: Participants discussed the differences in mentor teachers practices and how this influences their learning during teaching practice

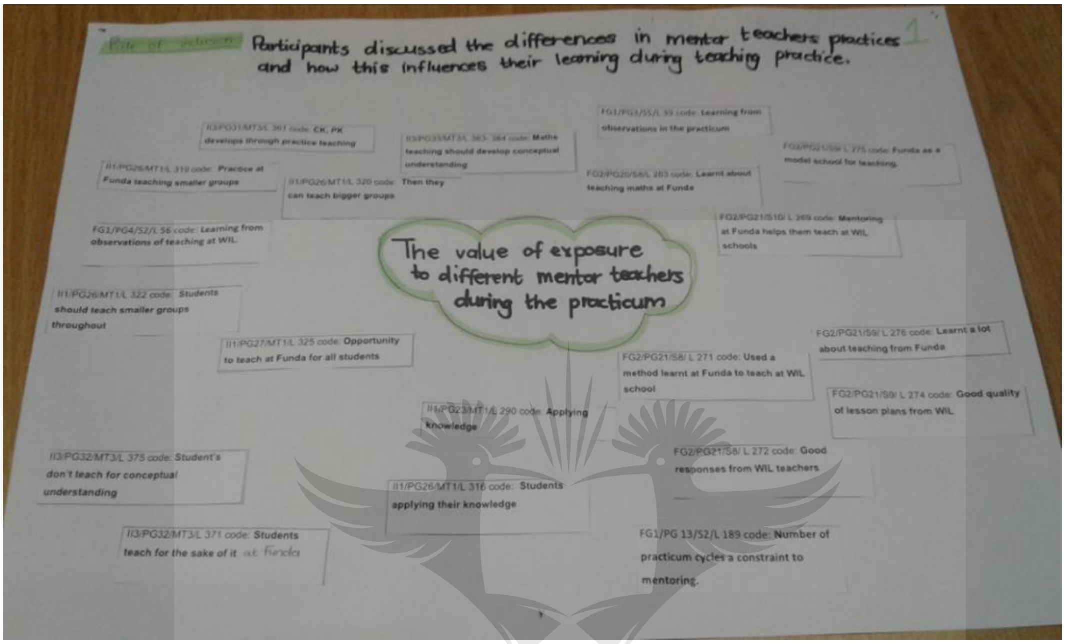


Figure 4.7.1.1 Mind map

This category of codes clusters input from participants about their experiences of mentoring within the teaching school. Student teacher's responses point to the value of having been exposed to different mentor teachers over time as this directly impacts the development of their PCK and GPK.

4.7.2 Provisional category 2: Mentoring practices influence students learning

Rule of inclusion: Participants describe the different mentoring practices and how it influences what they learn during the practicum

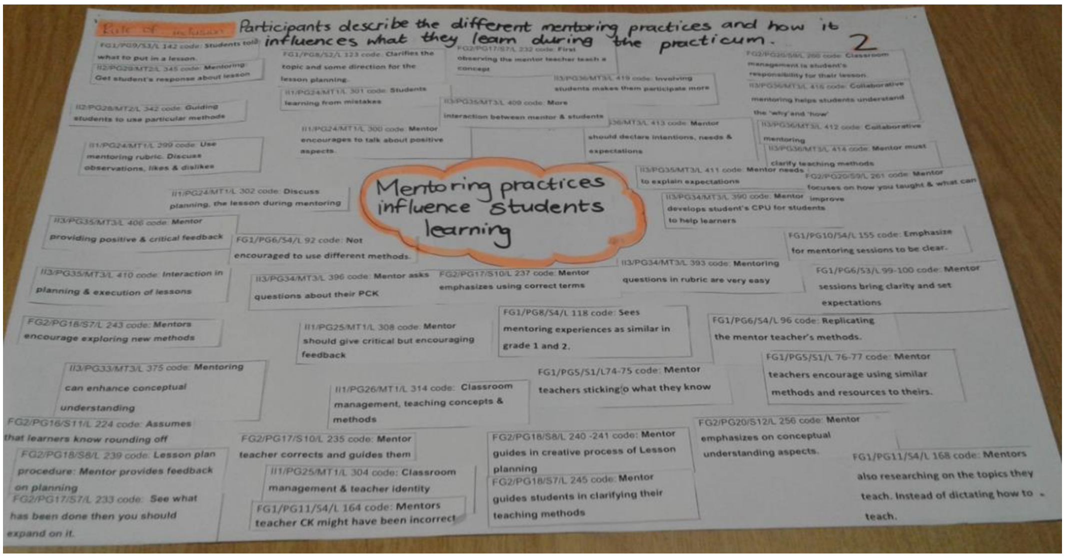


Figure 4.7.2.1 Mind map 2

In this clustering, I focused on putting together the students' descriptions of the different mentoring practices, which influence their learning. For instance, here I included the views of students about how mentor teachers guide and correct the mathematical language they use.

4.7.3 Provisional category 3: The importance of mathematics content knowledge

Rule of inclusion: All participant's express the view that mathematical content knowledge and recognizing learner's prior mathematical prior knowledge is important for teaching

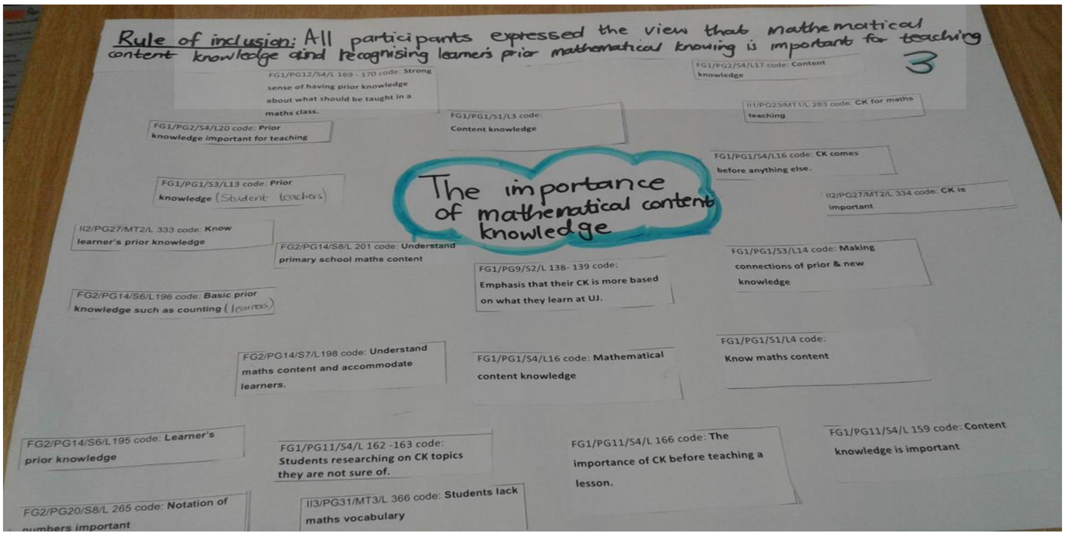


Figure 4.7.3.1 Mind map 3

This category is about student teachers' recognizing the importance of mathematical content knowledge and its role in their own teaching. Here participants spoke about what they consider important for teaching and for developing pedagogical content knowledge for mathematics. Many referred to content knowledge as an important pre-requisite for mathematics teaching. There was also emphasis on learner's prior mathematical content knowledge. Mentor teachers too highlighted the importance of mathematical content knowledge.

4.7.4 Provisional category 4: Interactive teaching methods learned from mentor teachers

Rule of inclusion: All participants expressed by giving examples of teaching methods which they observed and learned from their mentor teachers.

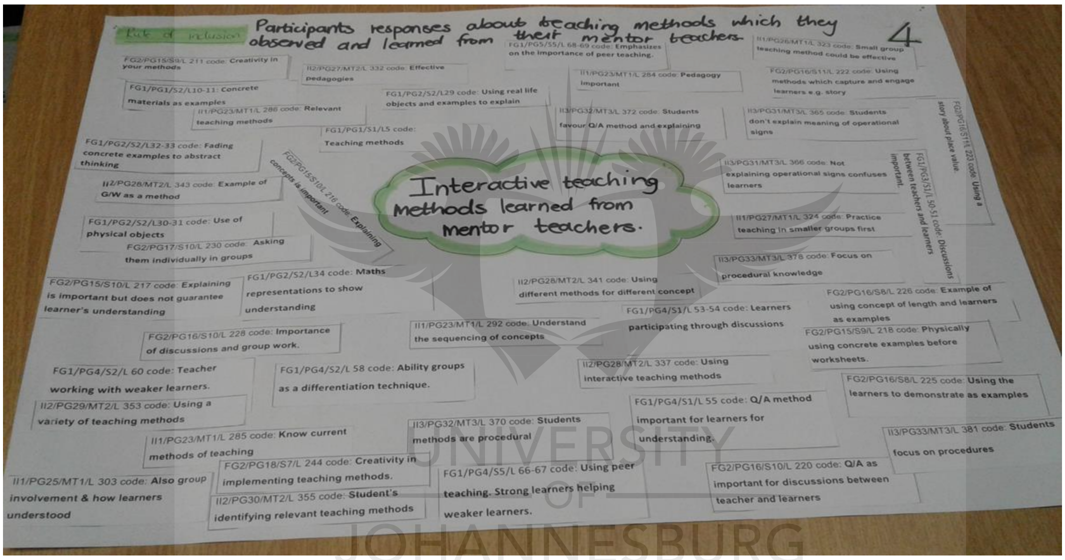


Figure 4.7.4.1 Mind map 4

This provisional coding category is about the different teaching methods, which student teachers have learned from mentors for the teaching of mathematics, including question and answer, peer teaching or group guided teaching through differentiation.

4.7.5 Provisional category 5: The value of being aware of different learning styles

Rule of inclusion: Students and mentors are aware of the different learning styles for mathematics teaching and how this affects teaching.

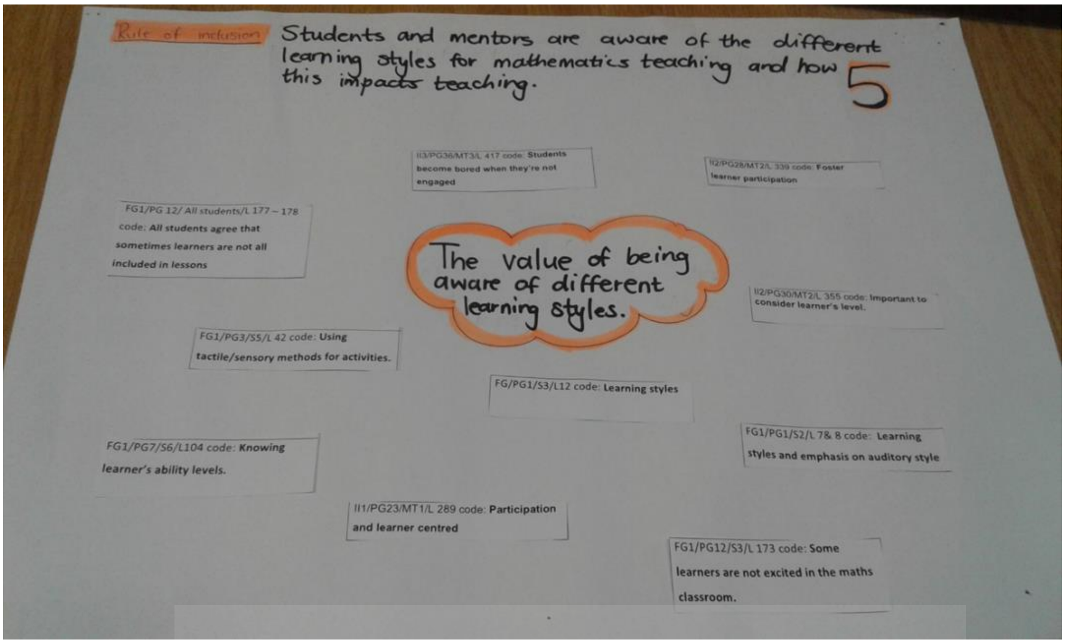


Figure 4.7.5.1 Mind map 5

This provisional coding category is about the student teacher's awareness of the various learning styles, which mentor teachers engage in when teaching. Mentor teachers described how they become more aware of their learning styles when they are mentoring and being observed by student teachers. It is also about being aware of learner's ability levels and understanding how different learners learn and understand mathematics. Student teacher's also recognize the importance of differentiated learning as part of meeting the learner's needs in order for learning to take place.

4.7.6 Provisional category 6: The importance of teaching aids

Rule of inclusion: Teaching aids are an important resource to supplement the chosen teaching method in mathematics.

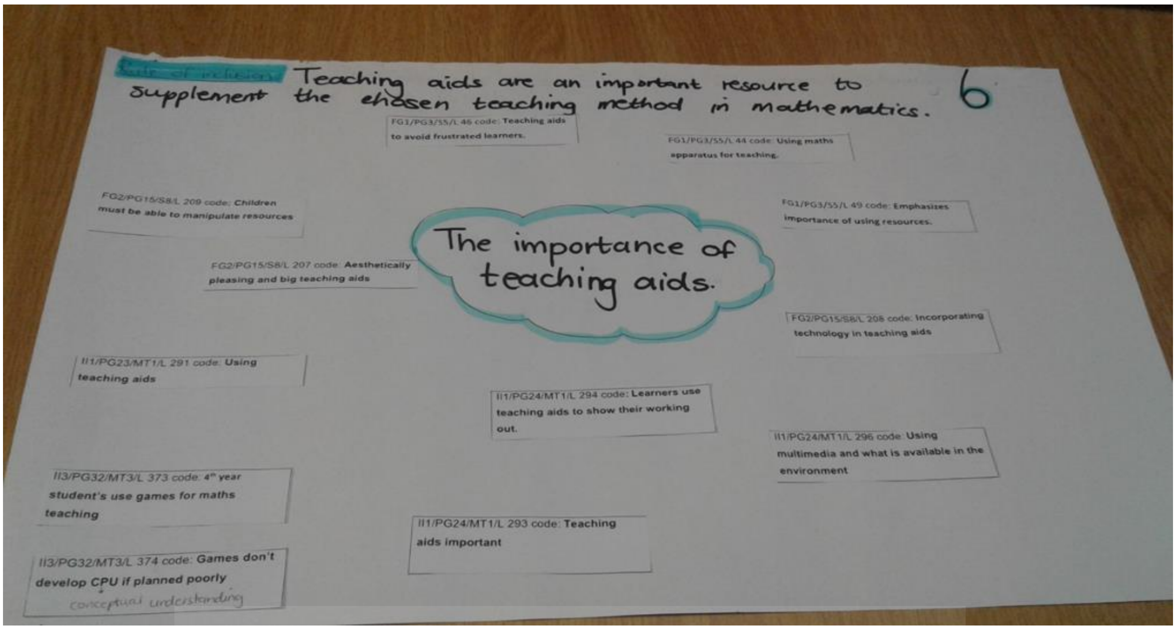


Figure 4.7.6.1 Mind map 6

This provisional coding category reflects the importance of using concrete materials or teaching aids to assist with teaching mathematics. Student teachers and mentors expressed how the use of teaching aids assists in making abstract concepts much easier for learners to understand. The use of teaching aids was regarded as important for mathematics teaching because student teachers felt that teaching aids also improves how they teach.

4.7.7 Provisional category 7: Developing reflective practice

Rule of inclusion: Effective teaching of mathematics requires that teachers and students develop reflective practice during their practicum.

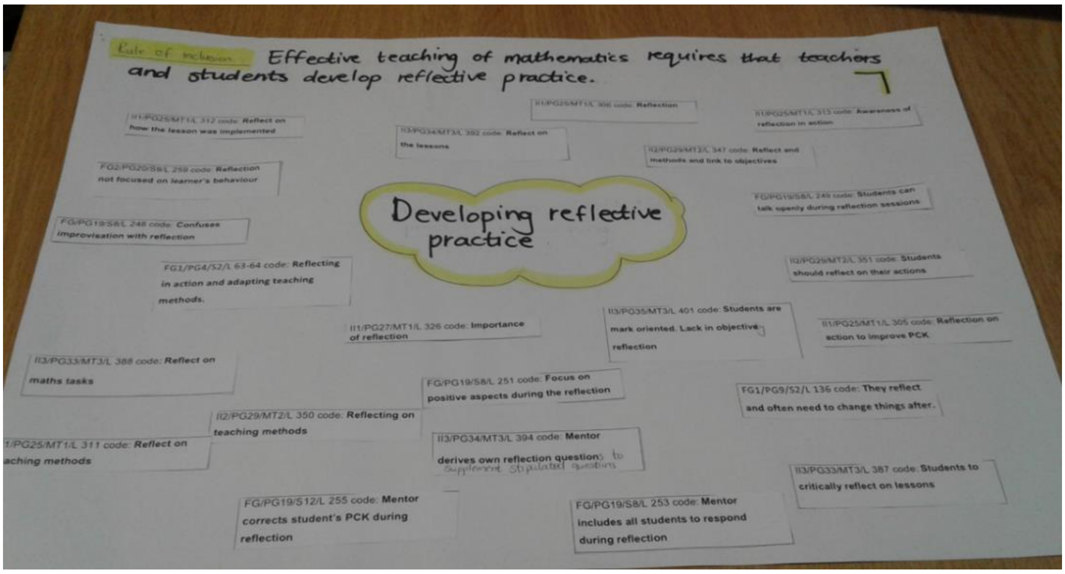


Figure 4.7.7.1 Mind map 7

The provisional coding category encapsulates how mentor teachers guide student teachers in developing reflective practice during the lesson planning stage and after students have presented their lessons. Mentor teachers also expressed how the use of the reflection rubric is a starting point for guiding reflective practice but should not be limited to the rubric only. Students however, felt that the reflective practice was limited to teaching and lesson planning. Students also recognized reflective practice as an important aspect of teaching but some did not see its importance in improving their PCK.

4.7.8 Provisional category 8: The teaching school as a mentoring laboratory and student teachers impressions of mentoring

Rule of inclusion: Participants experiences regarding mentoring and how they feel about the mentoring sessions, which take place at the teaching school.

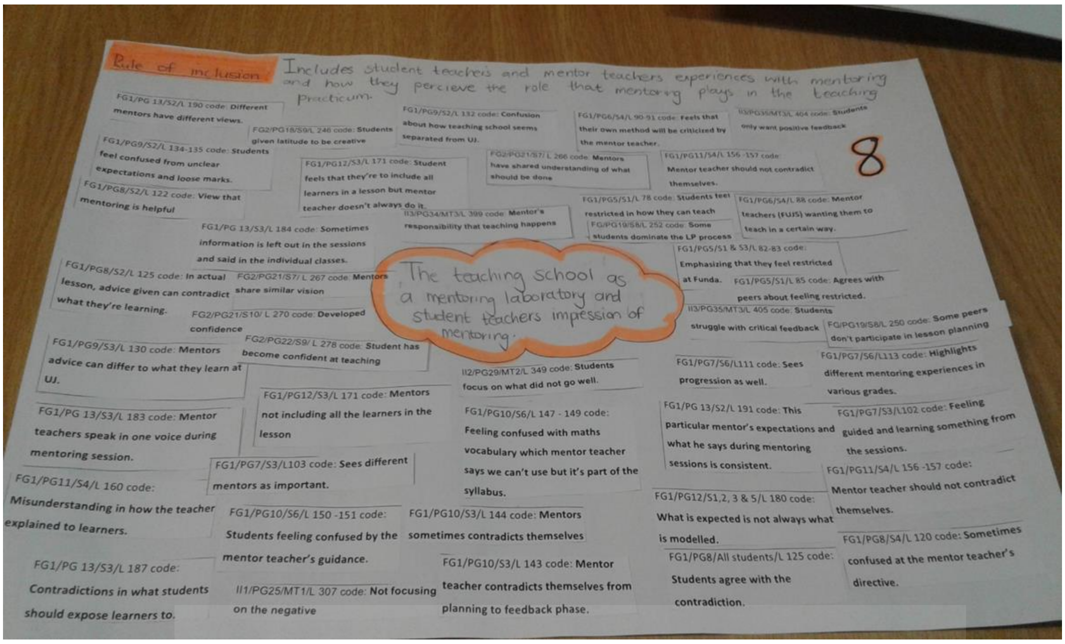


Figure 4.7.8.1 Mind map 8

This category is about student teacher's experiences with mentoring and its impact on the practicum. Student teachers expressed the view that mentoring assists and influences how they teach. Most student teachers expressed how positive their mentoring experiences with their mentor teacher is some said that they felt restricted and not given the latitude to teach how they thought would be best.

4.7.9 Provisional category 9: Linking coursework with practice in the practicum

Rule of inclusion: Participants explained how university coursework and the practicum come together (or not) during the mentoring/practicum

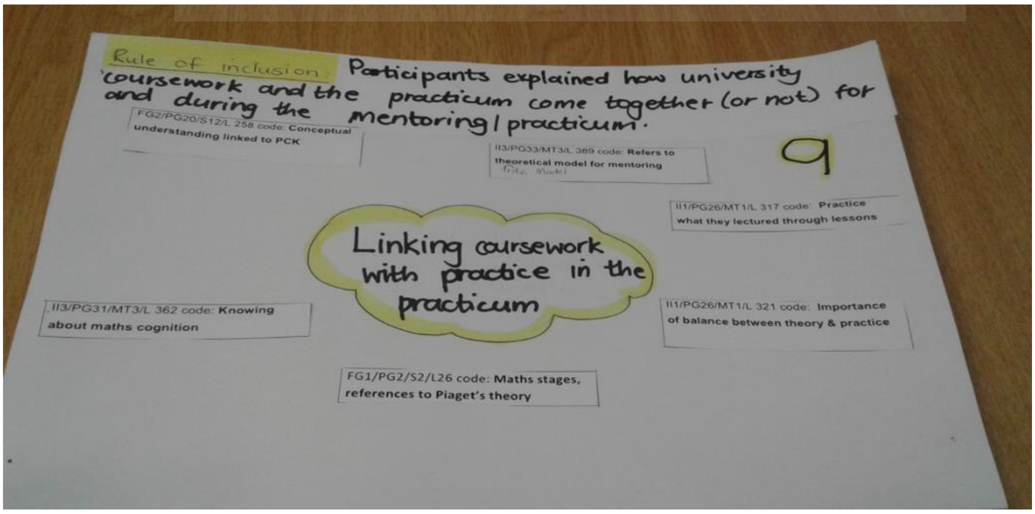
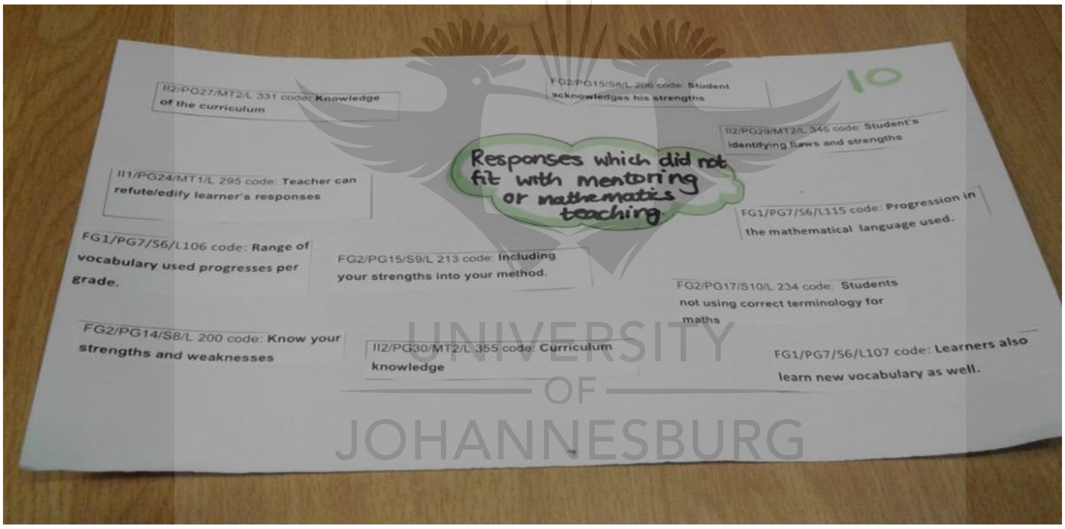


Figure 4.7.9.1 Mind map 9

This provisional coding category is about the participant's responses regarding the integration of university course work and the practice and how this finds expression in the mentoring process. Mentor teacher's responses were limited in this regard, as only one mentor expressed the importance of how students use the theoretical knowledge and link it with the knowledge they gain from the practicum.

4.8 Participants' responses, which do not fit with mentoring and mathematics teaching

The following units of meaning did not fit in anywhere in other categories related to mentoring of student teacher and mathematics teaching in general. The ideas expressed were not similar and were grouped together. *Some of the participants responses were given to expand on their examples but did not really fit with the questions they were asked.*



4.9 Provisional categories to categories

After the provisional categories were created. The categorizing process enabled me to develop what Lincoln and Guba (1985:347) refer to as a 'reasonable reconstruction of the data' that I have collected. The process of categorizing the provisional categories is about looking for similarities and patterns in the data set to see which provisional categories can be merged together for form a new category. Table 4.9.1. provides a list of the provisional categories.

Table 4.9.1 Provisional categories derived from units of meaning

1. The value of exposure to different mentor teachers during the practicum. 2. Mentoring practices influence students learning. 3. The importance of mathematical content knowledge. 4. Interactive teaching methods learned from mentor teachers. 5. The value of being aware of different learning styles. 6. The importance of teaching aids. 7. Developing reflective practice. 8. The teaching school as a mentoring laboratory and student teachers impressions of mentoring. 9. Linking coursework with practice in the practicum.

The following diagrams labelled 4.10.1 to 4.10.5 show how the provisional categories were merged in order to create new categories. Each category is followed by an explanation of the salient relationships between the provisional categories. This process is referred to as the refinement of provisional categories (Maykut & Morehouse, 1994). Refined categories are created by clustering together provisional categories, which have some linking ideas or similarities. The category then consists of ideas that fit together from the provisional categories. Following each category will be a discussion about why those specific provisional categories were merged.

4.10 Step 2: Creating categories

The process of creating categories consists of extracting salient points from the provisional categories. I was also informed by the raw data, my conceptual framework, theoretical framework and knowledge of the setting and experience in order to synthesize the data.

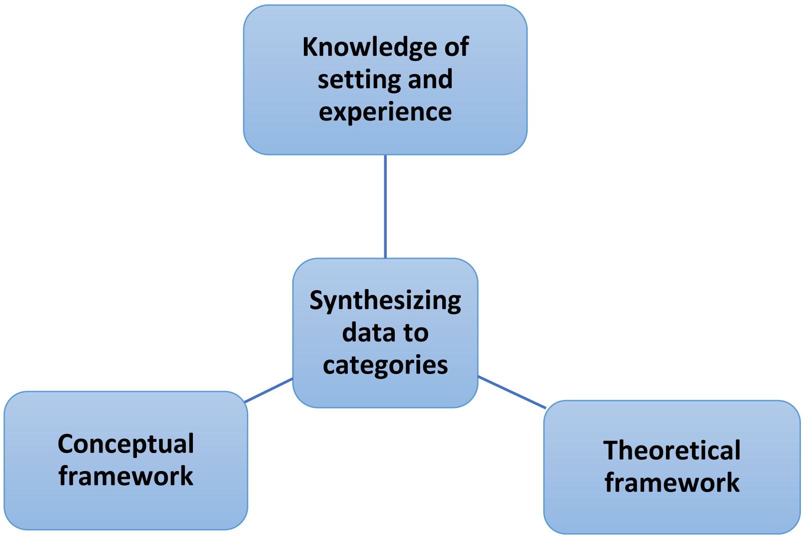


Figure 4.10.1 Synthesizing the data to create categories

I used my knowledge of the setting and my experience of teaching in a teaching school to inform how I put the data together. This required me to reflect on my experiences as a mentor teacher and use that knowledge to understand and interpret data from the participants mentor teachers and student teachers in this study. The conceptual framework which guided my interpretation of the data is based on the literature I read regarding mentoring and mathematics teaching. The theoretical framework which guides this study is Schoenfeld and Floden's (2014) Teaching for Robust Understanding (TRU Maths) framework which is about the robust teaching of mathematics.

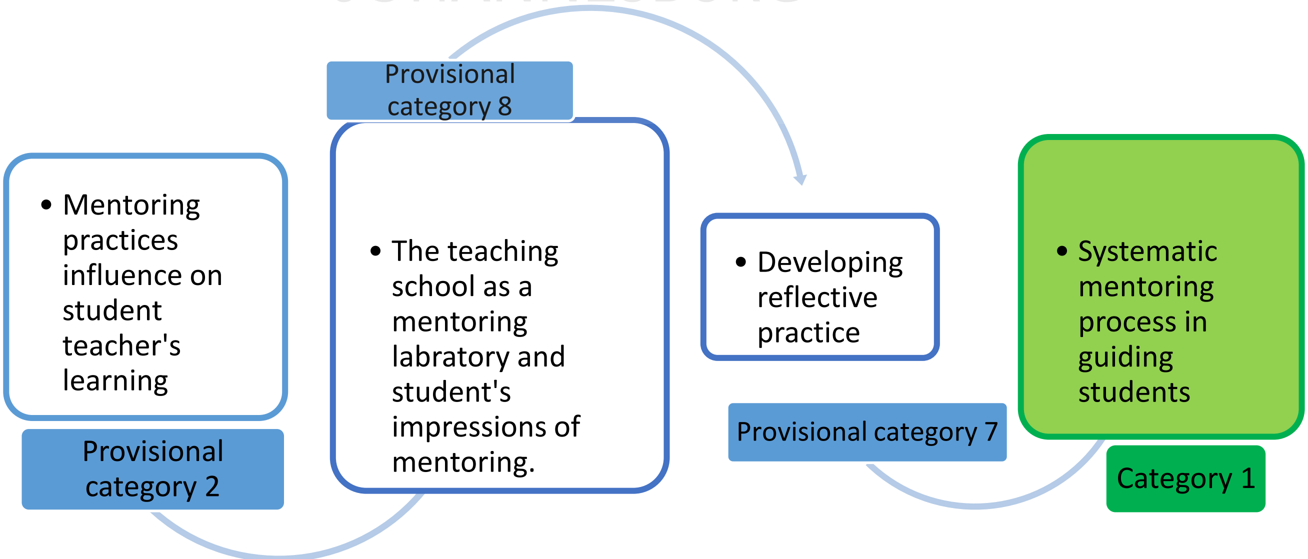


Figure 4.10.2 Creating category 1: Teachers follow a systematic process of guiding student teachers

This category was formed by merging three provisional categories where the ideas expressed in each provisional category fit together with the other provisional categories. The first provisional category about the mentoring practices which influence how student teacher' learn fits with the provisional category about student teacher's impressions of mentoring. This is because students develop an view or perception of mentoring based on the kinds of practices they see while being mentored. The teaching school serves as a mentoring laboratory for both mentors and student teachers to experiment with teaching practices that can improve the process of teaching and learning at the school. The mentoring, which takes place at the school also serves to expose student teachers to best teaching practices which they learn through mentoring. The third provisional category is about student teachers developing reflective practice. This process is about applying reflective practice techniques such as reflecting for action, reflecting in action and reflecting on action by having the mentor model this kind of practice. The combination of these categories address issues of mentoring in a teaching school and using reflection as a method of improving mentoring practices.

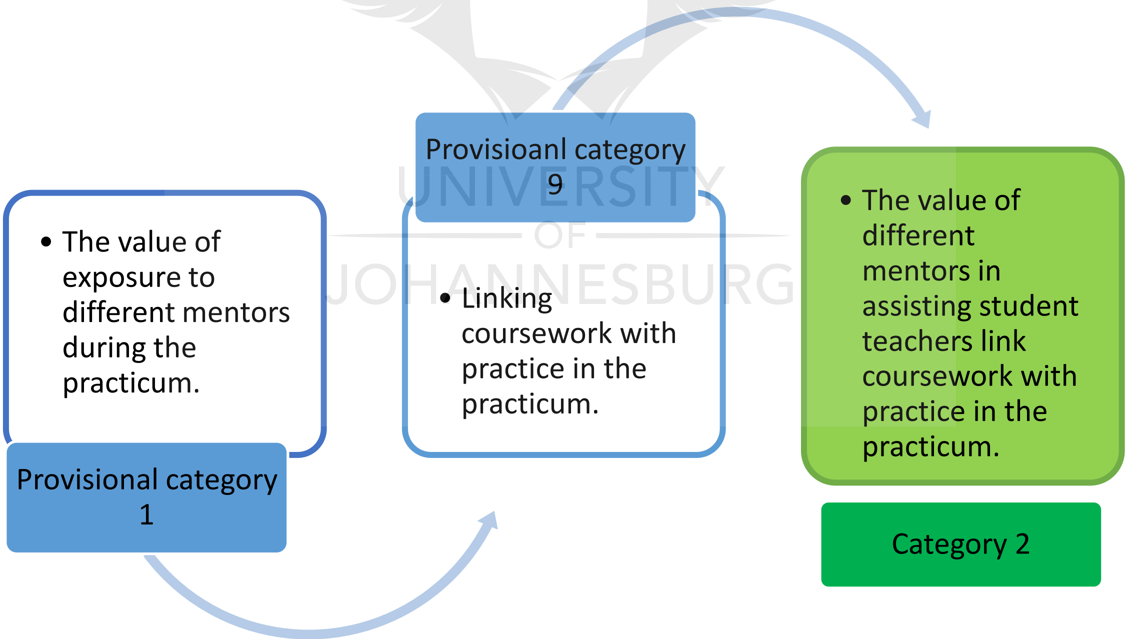


Figure 4.10.3 Creating category 2: The value of student teachers having different mentor teachers

This category was formed by merging the above provisional categories because each provisional category addressed an aspect of the practicum. The one provisional category is about the value of different mentors for student teachers and the other provisional category is about how mentor teachers help student teachers link their coursework with teaching practice during the practicum. The combination of these provisional categories addresses aspects of the contribution which various mentor teachers make in helping student teachers link their coursework with practice during the practicum. This is important because student teachers can learn multiple ways of linking theory with practice during practicum sessions. A core duty of the mentor in mentoring student teachers is how they help student teachers understand how their university coursework should be integrated with classroom practice. This becomes the essence of mentor teachers helping student teachers learn how to teach.

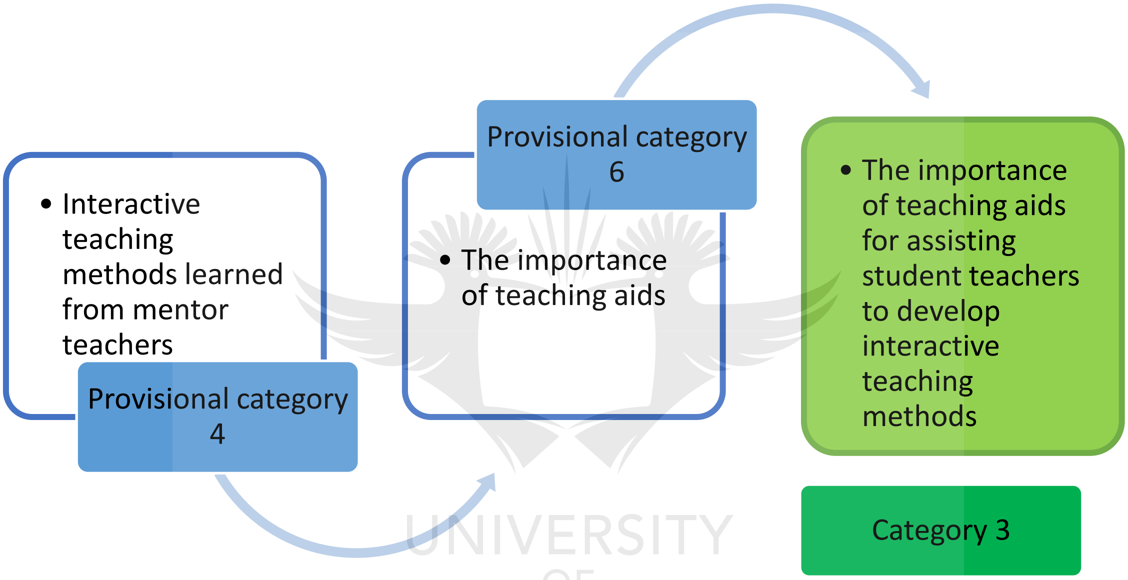


Figure 4.10.4.4 Creating category 3: The importance of teaching aids to develop student teachers' teaching methods

This category was created by merging the above provisional categories because they both address what the teacher needs to do in order for learning to take place. The one provisional category is about the kinds of teaching methods which student teachers are exposed to. Student teachers expressed that their mentors made use of interactive teaching methods by giving examples of the teaching methods their mentor teachers used. The category links with the other provisional category about the importance of using teaching aids in order to make abstract ideas comprehensible for learners. The process of allowing learners to manipulate teaching aids usually requires the teacher's guidance and will therefore allow the teacher to interact with the learners more effectively. The combination of these two provisional categories is about the importance of how to teach and using teaching resources, which enrich the teaching and learning process.

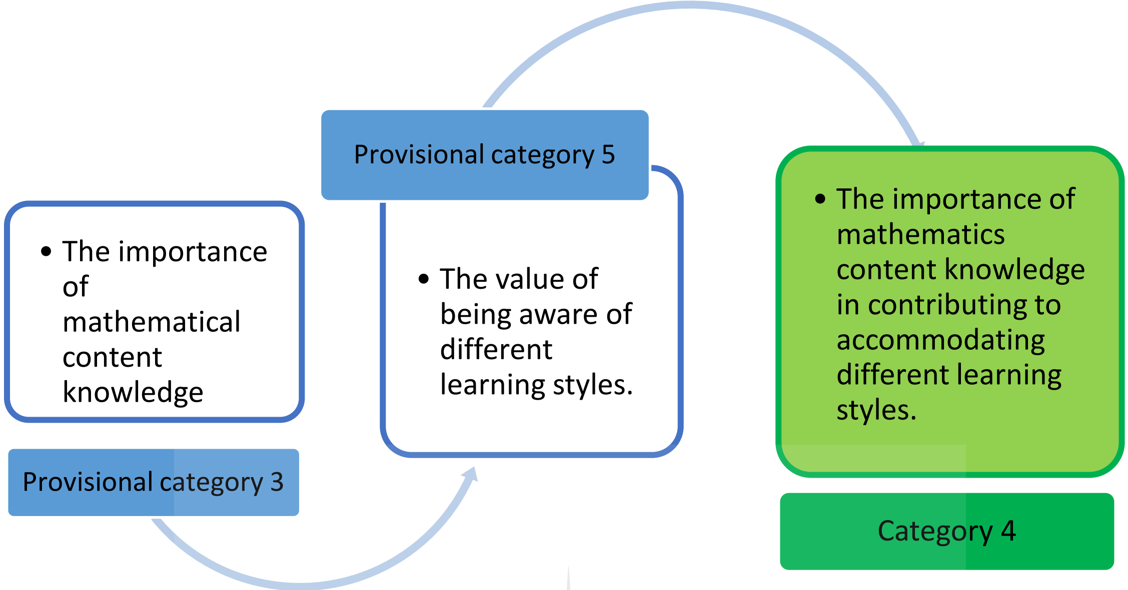


Figure 4.10.5 Creating category 4: The importance of mathematics content knowledge for accommodating different learning styles

This category was formed by merging two provisional categories in which one is about the kind of specialized knowledge teachers need in order to teach mathematics and the other is about being aware of the various ways in which learners learn. It is important for teachers to know and understand what learning style are. Auditory, visual and bodily-kinaesthetic learning styles can be used a way of channelling mathematical content knowledge into pedagogical content knowledge. This is because it makes teachers aware of the kind of content they need to know and understand and how they are going teach this content to children. Furthermore, it is important for student teachers to see this this explicitly. Mathematical content knowledge remains the teachers own knowledge and does not benefit the learner if the teacher cannot relay the content to learners in a manner, which they will be able to understand and apply the knowledge for learning purposes.

4.11 Step 3: Exploring relationships and pattern across categories

In continuing to systemically analysing the data, it is important to look for relationships and patterns across the categories. This process is the third step in the constant comparative method (Glaser & Strauss, 1967) which provides an over-arching framework for the data analysis process. Table 4.9.1 includes a list of the categories, which were formed from the provisional categories. These categories will further be analysed in order to create themes. Following this will be a discussion of the relationships between and patterns between the categories that form the themes.

Table 4.11.1 Categories derived from provisional categories

Category 1: Systematic mentoring process in guiding students teach mathematics in the foundation phase.

Category 2: The value of different mentors in assisting student teachers link coursework with practice in the practicum.

Category 3: The importance of using teaching aids to enable mentor and student teachers to engage learners in interactive teaching methods.

Category 4: The importance of mathematical content knowledge in contributing to accommodating learners' learning styles.

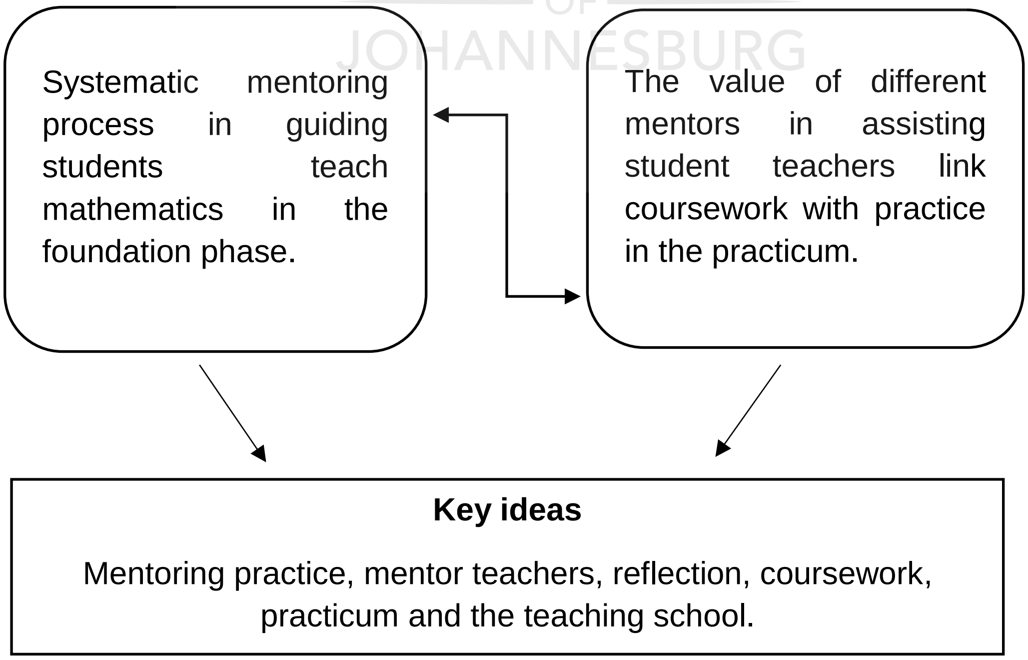


Figure 4.11.1 Exploring relationships between category 1 and 2

The relationship between these two categories is that mentoring is described as a central idea for student teachers as a means of improving their teaching practice. Mentoring practices can be compared or linked to mentors because it is unique to the role of the mentor. Student teachers cannot mentor themselves but rather learn from mentor teacher's practice. Mentoring practices also link with coursework because the process of mentoring should show student teachers how the their university coursework links with the practicum. Teaching practice links with reflective practice because student teachers need to be engaged in reflection in order to improve their teaching. The teaching school (mentoring laboratory) links with the practicum because the practicum experience is designed for students to learn how to teach and learn from their mentor teachers. Subsequently, mentor teachers should also improve their teaching as they reflect and mentor student teachers.

The importance of using teaching aids to enable mentor and student teachers to engage learners in interactive teaching methods.

The importance of mathematical content knowledge in contributing to accommodating learner's learning styles.

Key ideas

Teaching aids, teaching methods, learning styles, mathematical content knowledge

Figure 4.11.2 Exploring relationships between categories 3 and 4

There is a relationship between these two categories because key ideas between the categories link with one another. The use of teaching aids is important when teaching and also relates to using different learning styles. Teaching aids help the teacher explore other learning styles by using visual aids such as pictures and videos and also tactile learning styles through engaging learners in activities which make use of the senses. There are also links between mathematical content knowledge and the teaching methods teachers use. Innovate teaching methods could suggest that the teacher has exceptional mathematical content knowledge and it reflects in the pedagogical knowledge.

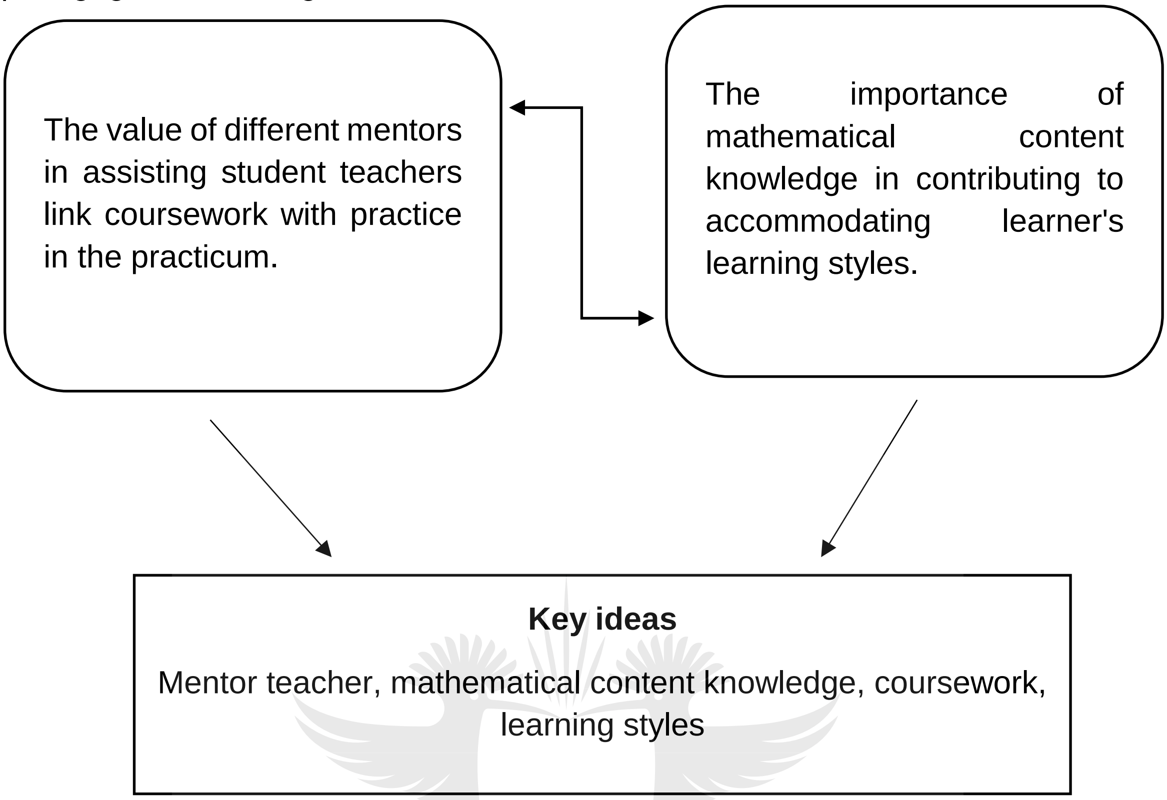


Figure 4.11.3 The relationship between category 2 and 4

The value of student teachers being exposed to different mentors teaches them differently ways of implementing mathematical content knowledge. This can be evident in how student teachers observe a particular concept taught in the various grades. An example could be students recognizing the mathematical content knowledge required for teaching measurement but this is executed differently in grade 1-3. Student teachers learn how their coursework is applicable for the various grades in the foundation phase. They value of being of exposed to different mentor teachers links with learning styles because they will observe each mentor teacher teach the same content differently at a grade appropriate level.

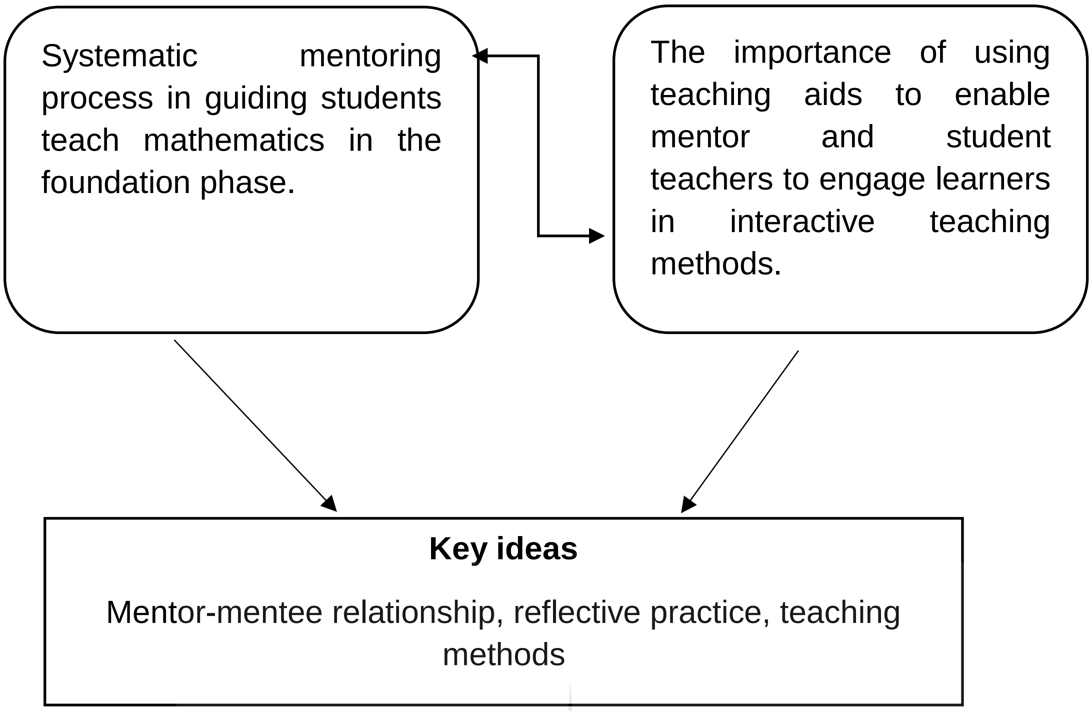


Figure 4.11.4 The relationship between category 1 and 3

Mentoring practices, which student teachers observe and learn expose student teachers to different kinds of teaching methods. Student teachers would be able to see reflective practice is fundamental to improving their teaching methods. This is because the process of reflection will enable them to think about and evaluate their teaching. As they also observe their mentor teachers, they need to also reflect on the teaching methods that they are observing and see how they could also use them. The relationship between the mentor and student teacher is important in both categories in order for mentoring to occur. The teaching school remains central to the practice of mentoring for student teachers and it is where student teachers first encounter a mentor teacher. The relationship between the mentor and mentee becomes important for the process of mentoring to occur.

4.12 Themes emerging from the categories

Themes in qualitative research are the overall results, which emerge from the data analysis process. They are generated through a rigorous and systemic analysis of the data (Maykut & Morehouse, 1994: Henning, Van Rensburg & Smit, 2004). The following are themes that emerged from this process.

4.12.1 Overarching finding

The newness of the teaching school, the practicum and mentor teachers experiences led to a procedural form of mentoring with minimal developments of student teacher's development of a robust understanding of mathematics teaching. Mentoring is necessary to enhancing and developing student teacher's PCK. Furthermore, the views of mentor teacher highlight that it is necessary for mentor teachers to reflect continuously on their teaching practice. Similarly, student teachers views highlight that they learn immensely from their observations of mentor teachers in the teaching school. The overarching finding correlates with the research question posed in this study is evident in the findings that are discussed in the emerging themes. Within this finding, these themes are discussed:

Theme 1:

4.12.2 Student teacher and mentor teachers recognise the importance of mathematical content knowledge as a pre-requisite for teaching mathematics and for optimal mentoring to occur.

- Planning for teaching
- Absence of theoretical knowledge in lesson planning
- Students and mentor teachers understanding of the curriculum and mathematical content knowledge.
- Teaching aids for enhancing mathematical PCK

Theme 2:

4.12.3 Mentor teachers and student teachers experiences of the mentor-mentee relationship.

- Student teacher's experiences of the mentor-mentee relationship.
- Difficulties experienced by mentors and student teachers regarding the practicum.
- Mentor teachers using a systematic process of guiding students, which is informed by university protocol documents.

Theme 3:

4.12.4 There is value to student teachers having different mentor teachers over the course of their studies.

- Teaching methods observed by student teachers during the practicum.
- Student teachers impressions of their mentor teachers.

4.13 Conclusion

In this chapter, I discussed the data analysis process. I drew primarily on the work of Maykut and Morehouse (1994) as an analytical tool and elaborated on how I used the constant comparative method (Glaser & Strauss, 1967) as an over-arching framework to analyse the data. The codes that emerged from the raw data provided a basis for developing categories from the data. By using the constant comparative method, I was able to draw correlations between the participants' responses and categorize the data accordingly. Furthermore, this enabled the analysis of looking for patterns within these categories and further refining the categories to develop themes. These themes will be discussed in the following chapter together with incepts of the raw data.

CHAPTER 5:
FINDINGS & DISCUSSION

5.1 Introduction

The newness of the teaching school, the practicum and mentor teachers experiences led to a procedural form of mentoring with minimal developments of student teacher's development of a robust understanding of mathematics teaching in the foundation phase. However, teachers leveraged their extensive classroom and teaching experience of mathematics, in collaboration with students in the interactive practicum to mentor students and to the benefit of both student and teacher development. In coming to this conclusion, I drew on the main three sub-findings of this study. These sub findings include the importance of mathematics content knowledge in teaching, mentor teachers and student teacher's experiences of the mentor-mentee relationship and value of student teachers having different mentor teachers over the course of their study.

In the ensuing discussion I expand on the contribution of each of the three interrelated themes that led to the construction of this finding, drawing on extracts of the data and the appropriate literature to show how these fit within the broader debates in mentoring for student teacher learning (of mathematics teaching) in the foundation phase. I also draw on the theoretical lens of Teaching for Robust Understanding (TRU Maths) (Schoenfeld & Floden, 2014; Hudson, 2013; Hudson & Peard, 2005).

5.2 Recognising the importance of mathematics content knowledge in teaching

Student teachers and their mentor teachers recognise the importance of mathematics content knowledge as a pre-requisite for teaching mathematics and for optimal mentoring to occur. Schoenfeld's (2016) TRU framework addresses five core aspects of effective mathematics teaching, one of which is content knowledge. It is possible that the emphasis by students is because of the prominence of content knowledge in the foundation phase curriculum of the teacher education programme where students have six mathematics content courses in the four years. Here foundation phase students cover the mathematics content required for teaching in the primary school up to grade seven. A foundation of solid mathematical content knowledge is understood by student teachers to be instrumental in the development of student teacher's pedagogical content knowledge. The importance of mathematics content is also emphasized in practicum component of the third year methodology (teaching didactics/ methods) courses of the programme, where the different knowledge types of teachers (according to Shulman, 1986;1987) serves as a basis for unpacking what student teachers need to know to operate as effective teachers. Students engage with the different knowledge types as put forward by Shulman (1987) and others such as Hudson and Peard (2006), Hudson (2007) and Hudson (2013) from their first year and so it is likely that the prominence of this aspect in the data from students emanate from this emphasis. Furthermore, as the students' methodology courses address other aspects of mathematical content such as mathematical big ideas, mathematical thinking processes and integration with the CAPS (2011) curriculum they need to learn how these concepts are important in actual mathematics teaching. They also learn that the implementation of these mathematics concepts should be evident in their lesson planning and teaching of mathematics concepts.

In addition, students are quite aware of the limitations of their own mathematics content knowledge from school. At the institution where this study was conducted students are part of studies such as the one reported on by Fonseca and Petersen (2015) where their mathematics content knowledge was tested in the first few months of their entry to university. Here Fonseca and Petersen (2015) show that on average students enter university knowing 37% of the mathematics content required as a first year student. After a ten-week revision course, students then test 51% on a post-test. Staff takes a pragmatic approach in sharing results with students to enable them to recognize their current mathematics content levels and to assist them through supplemental instruction to help them improve. From 2017, students have also participated in national mathematics baseline test as part of the PrimTed research project (2017). Here too, they are made aware of their mathematics scores. The results in 2017 showed that 180 first year foundation phase students achieved a mean score of 46.9 % and in from the 2018 cohort 117 first year students achieved a mean score of 48.87% in 2018 (Fonseca, Maseko & Roberts, 2018). This is comparable to results from the same test at other higher education institutions in South Africa, showing how widespread the problem of mathematics content knowledge is.

From the perspective of teachers, the university's constant emphasis on how low content knowledge of practicing teachers has detrimental effects on the educational outcomes of young learners in combination with the almost prescriptive nature of the foundation phase CAPS mathematics curriculum (Reddy, 2006) points to possible reasons for its prominence in the teachers' data. Authors such as Hudson and Peard (2006) argue that the importance of MCK as one of the foundational knowledge bases, which are developed in mathematics content courses in initial teacher education, cannot be overestimated. Student teachers and teachers recognize that mathematics content knowledge as part of pedagogical content knowledge is valuable because it enables student teachers to connect new concepts with existing knowledge. In the next section, I will discuss the importance of learners linking their prior knowledge with new mathematical concepts.

5.2.1 Making connections with what learners already know

The ability to make connections with the learner's prior knowledge is considered an important mathematical skill. Prior knowledge can be described as the knowledge one already has about a concept and it links with the content domain of the TRU framework (Schoenfeld, 2016). This is particularly important because mathematics content consists of concepts which learners have learnt and concepts that they will still learn. Student teachers indicated the importance of being able to understand learner's prior knowledge before they teach a new mathematical concept and this aspect is highlighted in the data:

FG1/S3/PG 128/L12-14: *'I think it is also important that the teacher knows the learner's prior knowledge because if we as teachers don't know their prior knowledge, then how will we know what we supposed to build up on'?*

FG2/S6/PG 132/L194-195: *'So the first thing you need to know is what the students know first about maths. Then we can take it from there about what we're going to teach them. So like just basic maths, do they know how to count'?*

Likewise, mentor teachers also expressed the importance of recognizing learner's prior knowledge before teaching a new concept. This is to ensure that the teacher elicits learner's prior knowledge before teaching another mathematical concept. Typically, in actual teaching episode it would include the order of teaching concepts such as eliciting learner's prior knowledge about addition before teaching them multiplication. The following extract from a mentor teacher describes the importance of eliciting learner's prior knowledge.

II2/MT2/PG139/L332: *'Also they must know the basic or estimated prior knowledge of the learners'.*

The importance of making connections or understanding learner's prior knowledge is important for mathematics teaching (Hudson (2007), Hudson and Sempowicz (2011) Schoenfeld, 2016). Student teachers and their mentors inputs suggest that they take cognizance of eliciting learners mathematical prior knowledge which features in the mentoring sessions. However, prior knowledge was just mentioned as an abstract idea that was not connected to any meaning or examples. This provides evidence that both teachers and student teachers may not have internalised this in teaching or in the mentoring. I conclude that eliciting learner's prior knowledge is a probable more procedural step rather than helping learners develop conceptual understanding in making connections between the various mathematical tasks. Student teachers need to be guided through mentoring to ensure that learners understand the connections between the various mathematical concepts as they elicit their prior knowledge (Schoenfeld & Floden, 2014).

5.2.2 Planning for teaching

Planning for teaching was also indicated as another important aspect as part of teaching in general. The set-up of the practicum provides student teachers with the opportunity to implement their lesson plans in classrooms with learners. This task is different from when they are learning how to design mathematics lesson plans in their methodology classes. Lesson planning for teaching purposes entails student teachers developing and refining their lesson plans under the guidance of their mentor teacher and is supposed to be a rigorous process as mentor teachers and student teachers have three to four days to refine the lesson before implementation. In the context of this study, student teachers do not seem to find the process of lesson planning daunting because they have become accustomed to it over the duration of their studies with input from mentor teachers. Many of the students commented on this saying that the mentor teachers input develops their confidence about teaching and as a result they do not feel threatened or intimidated by this aspect of learning to teach. However, a minority expressed that they sometimes feel that the mentor teacher imposed her views regarding the creative direction of the lesson. The following extracts highlight student teacher's views of the process of being mentored for lesson planning.

FG2/S10/PG138/L269: *'We're confident when we're standing in front of the learners because we're used to it here at the teaching school'.*

FG2/S9/PG137/L277: *'You become extremely confident and everything you do you do it at the best of your abilities'.*

Mentor teachers also regard lesson planning as an important step in getting student teachers to learn how to teach. Leinhardt (1993) argues that one of the roles of expert mentor teachers is to guide novice teachers in developing their PCK. Lesson planning provides an indication of student teachers' developing PCK because they need to articulate their teaching methods before they implement them. However, vague articulation of their PCK is most likely not to develop any conceptual understanding of the mathematical concept. There is evidence of this struggle in the data, which shows that student teachers report that in their lesson planning they have difficulty with linking mathematics university content with their teaching methods. Hence, they will struggle with teaching mathematics concepts for conceptual understanding. One of the mentor teachers provided an example of the strategies/methods, namely games, students use to teach mathematics. The mentors comment is that despite her guidance in the creative process of designing the game students tend to focus on the procedural aspects of the game rather than on the conceptual aspect.

II3/MT3/PG141/L372-373: *'You know when they reach the fourth year level they try to come up with some sort of activities like a play, games mostly. However, you find that mostly in those games they are missing the teaching part of it. It is just playing games'.*

This raises concerns about how most fourth year student teachers still struggle to deepen the learner's understanding of various mathematical concepts. It is almost as if they are teaching concepts at a surface level rather than making sure that learners really understand what the concept entails. Examples of this are evident in elements of mathematics such as fractions, division and place value which student teachers consider difficult to teach. I argue that if student teachers are able to incorporate some opportunities for learners to engage in "productive struggle" (Schoenfeld, 2018).

The reflection session after the lesson provides student teachers with the opportunity to think about, with input from a mentor, how their method developed or did not fully develop conceptual understanding of the mathematical concept. Turner, Styer and Daggs (1997) highlight the importance of using teaching methods that focus on conceptual understanding of the concept rather than mastering technical and procedural steps. This is important to consider because in this study it is clear that although teachers understand the drive towards developing conceptual knowledge I am not always sure that they are able to guide students in designing captivating, detailed and policy aligned lesson plans that encompass all aspects of mathematical thinking processes or mathematical big ideas. I take this issue up in the next section.

5.2.3 The absence of theoretical knowledge in the lesson plans

Theoretical knowledge such as the awareness of mathematical thinking processes such as problem-solving, logical thinking and reasoning and mathematical big ideas are important for enhancing conceptual understanding of mathematical concepts (Askew, 2012). Student teachers learn about different kinds of mathematical processes such as reasoning, proofs, problem solving, making connections and representations in their methodology courses. Student teachers did not mention these ideas when asked what else they considered important for mathematics teaching other than content knowledge. This is particularly problematic because these ideas are supposed to guide how they teach mathematics concepts in the foundation phase of schooling.

It appears to me that the mentor teachers are also not aware of how these concepts form part of mathematics content knowledge. In the following extract, there is an attempt by the mentor teacher to elaborate on these constructs but I found the ideas somewhat vague even with probing.

II3/MT3/PG141/L361-362: *So it's more about the content knowledge, your mathematical cognition part of it. In the foundation phase it will be more based on your number sense specifically.*

II3/MT3/PG141/L388-389: *'So ummmh we've been using the model by Fritz[1] of number sense. I also try and assist them in building their conceptual knowledge of*

[1] Fritz, A., Ehlert, A., Balzer, L. (2013). Development of mathematical concepts as a basis for an elaborated mathematical understanding. *South African Journal of Childhood Education*, 3 (1), 22-38.

using the number sense, so that then they can be able to assist their learners in the classroom'.

In the interviews, neither student teachers nor their mentor teachers provide an in-depth account of their understanding of mathematics content knowledge related to a theoretical perspective. Responses about this kind of mathematical content knowledge were mostly related to their own practical knowledge of the mathematics curriculum. Student teachers said nothing about broader mathematical concepts such as mathematical 'big ideas' which students learn about in their university coursework. Theoretical knowledge is often quite difficult to integrate with teaching practice because of prevailing difficulties of linking theory with practice in teaching (Hudson; 2007; Hudson 2013). This I felt was important to note because even when student teachers were probed to elaborate further on what constitutes mathematics content knowledge, their responses were still limited to the mathematics content CAPS (2011) curriculum.

5.2.4 Student teachers understanding of the curriculum and mathematics content knowledge

The CAPS (2011) mathematics policy document is introduced to student teachers in their first year methodology classes and provides an overarching framework of the mathematics curriculum for the various phases of the school curriculum. The foundation phase students who took part in this study mentioned that they are taught about the mathematics content areas in the CAPS (2011) policy document as part of ensuring that they know which concepts need to be taught to learners. Shulman (1987) asserts that curriculum knowledge is an important domain of knowledge for teachers to know and understand. Student teachers need to know what is in the curriculum in order for them to know what to teach. However, I differentiate between the curriculum intended for learners and the mathematics content knowledge, which student teachers possess and learn in their university coursework, referred to as multi-dimensional knowledge (Hill, Schilling & Loewenberg-Ball, 2004). Thus, students' own MCK consists of knowing about the mathematics curriculum that they are required to teach to learners and university mathematics content courses are aimed at improving and extending their mathematics content knowledge beyond the level of foundation phase mathematics. Competence in mathematics content knowledge puts student teachers in a better position for teaching.

The data shows that that some student teachers believe that their ability to teach is based on how well they know the school mathematics curriculum, while others understand that it also includes a solid base of mathematics content knowledge and pedagogy. The former group believed that if they knew what is in the curriculum and then could teach the concept because foundation phase mathematics was perceived to be easier.

FG1/S4/PG131/L19-21: *'Content knowledge is the knowledge of maths and understanding what you need to teach to your learners. You can't really teach learners what you don't know or understand'.*

FG1/S1/PG131/L 2-4: *'I think as a teacher you should know what maths is and what it is about before you can teach children. You must know what you're going to teach'.*

FG2/S8/PG135/L199-200: *'I feel like what is important firstly, is understanding yourself as a maths teacher. Because you know what are your strongest points and your weakest point. You can't teach maths, if also you yourself you do not understand the basics of maths'.*

FG2/S6/PG135/L194-195: *'So the first thing you need to know is what do the students know first about maths. Then we can take it from there about what we're going to teach them. So like just basic maths, do they know how to count'?*

FG1/S4/PG131/L19-21: *'Content knowledge is the knowledge of maths and understanding what you need to teach to your learners. You can't really teach learners what you don't know or understand'.*

Mentor teachers on the other hand also considered school curriculum knowledge as an important domain of knowledge for student teachers to know in order for them to understand how to interpret the curriculum in the CAPS (2011) policy document. The CAPS (2011) curriculum includes knowledge of number operations and relationships, patterns, measurement, space, shape, and data handling. Mentor teachers emphasised the importance of understanding the cognitive demand of these content areas.

Schoenfeld (2016) in his TRU Maths framework argues that the cognitive demand of mathematics tasks is associated with the types of problems varying in difficulty in assessment tasks. In mathematics assessment, tasks such as recalling and memorization tasks such as counting would have a lower cognitive demand compared to problem-solving tasks, which would have a higher cognitive demand. This is important to note because it forms part of student teachers observations in mathematics foundation phase classrooms.

5.2.5 Teaching aids for enhancing mathematical content knowledge

Student teachers spoke about the use of teaching aids as an effective way of enhancing their pedagogical knowledge. It was rare to find extracts where student teachers did not mention the use of teaching aids when teaching at the teaching school or at WIL schools. Part of the pre-lesson mentoring session at the school involves discussions about what resources they will need to find or make in order to teach the concept well. In a study conducted in this setting from the perspective of a mentor teacher, Ntsoane (2018) argues that teaching aids are an important resource to use for enhancing how learners understand the mathematics concepts. Student teachers expressed how they were encouraged to make aesthetically pleasing teaching aids, which were also big enough for learners to use. These artefacts can prove to be effective in making the mathematical concepts less abstract for learners. Materials found in the natural environment such as stones, sticks and bottle caps could be used to teach mathematics concepts such as counting, addition or subtraction. One of the mentor teachers also stressed the importance of incorporating technology as part of student teachers' teaching aids. This includes student teachers using the smartboards in the classrooms as part of their teaching aids. The mentor teachers emphasized how their teaching methods need to develop 21st century skills and these skills can be developed using innovative teaching aids in the classroom.

II1/MT1/PG138/L284-285: *'They also need to know what's trending, the new methods and new ways of teaching maths. They need ways of teaching now, inconsideration of 21st century learner'.*

II1/MT1/PG138/L292-293: '*So what we tell them in their method is that they have to always have teaching aids for the learners. So that they apply their knowledge and they are able to show you their workings on how they got their answer'.*

II1/MT1/PG138/L295: *'And also exposing other learners to different methods. So it's basically using different ways and also multimedia. You can use videos, you can use pictures and you can use just even stones from outside'.*

Student teachers spoke about the importance of using aesthetically pleasing teaching aids, which support the understanding of mathematics concepts. Teaching aids are representations of abstract mathematical ideas into concrete ideas that they can relate to their world or environment (Ntsoane, 2018). The correct use of teaching aids limits learner's frustration because they are able to make sense of the mathematical concepts. Similarly, the views expressed by student teachers also include incorporating technology in their teaching aids. The following extracts highlight their views on the importance of teaching aids.

FG1/S5/PG131/L44-45: *'She would have the base ten blocks and I found that to be very good because can see what you're talking about. Rather than saying 700 is 700 and getting frustrated. At least learners can see so many blocks and so on'.*

FG2/S8/PG135/L208: ***'****Because sometimes cannot see what you're talking about, they need to see to be able to manipulate what you're talking about'.*

FG2/S8/PG135/L206-207: *'I would make a beautiful big watch with all the time intervals in it. It can even be electronic and make it move'.*

5.3 Mentor teachers and student teachers experiences of the mentor-mentee relationship

Successful mentoring occurs when there is an established productive relationship between the mentor and the mentee (Hudson, 2013). A successful mentor/mentee relationship is dependent on qualities which both the mentor and mentee find desirable. Mentoring teaches student teachers about forming and building relationships within the teaching profession (Hobson, Ashby, Malderez & Tomlinson, 2009). Therefore, it is imperative for mentor teachers to teach student teachers about forming professional relationships for their own professional development. Hudson (2013) describes the characteristics of a good mentor teacher as a person who can communicate, has respect for the mentee, is trustworthy and can collaborate with the mentee. Fisher (1994) further describes common characteristics of a good mentor as a mentor who can share their knowledge, demonstrates professional attitude, is enthusiastic and must be flexible to understand student teacher's views. In addition, Hudson (2013), found that in order for there to be effective mentoring, mentor teachers desired the following mentee attributes: being enthusiastic about teaching, having an interest in building relationships with mentor teacher and other staff members, displaying commitment to the children and their learning, having the ability to reflect on constructive feedback, having resilience and taking responsibility for their learning (Hudson, 2013:5). These qualities are fundamental for ensuring that mentor teachers and student teachers can form effective professional relationships.

In this study, I found that the mentor teachers of the mentor-mentee relationship is largely based on how often they interact with student teachers. They feel that because student teachers engage in the practicum as groups it is often difficult to have equally meaningful relationships with individual student teachers an issue I elaborated on, in section 5.2.2. about how the current practicum model impacts mentoring. However, on the whole I found that the teachers did not really allude to attributes they found desirable in student teachers, because they spoke much more about the importance of using different teaching methods. However, one mentor teacher emphasized the importance of students having solid mathematics content knowledge before they can learn or develop any PCK. The following extracts, report on the mentor teachers views.

II1/MT1/PG138/L295: *'And also exposing other learners to different methods'.*

II2/MT2/PG140/L331: *'If they are in the grade 2 class and then they also need to know the best approaches or the best methods to use to teach the learners effectively'.*

II3/MT3/PG141/L360: *'I think you need to know more of the content and we all know when it comes to the pedagogy that will be developed as they practice more'.*

The lack of response about this issue from the mentor teachers could also be attributed to my lack of experience as a researcher in probing this aspect during the interviews. One of the aspects that arose in the interviews from the perspective of the teachers is how students struggle with reflecting on feedback, even if such feedback is constructive and developmental. The inability of students to take constructive criticism was prevalent in all of the mentor teacher's responses and is best illustrated by the following extracts from the data:

II3/MT3/PG142/L404-405: *'You know when you start telling them about the bad things, some of them they feel withdrawn and they don't take criticism positively so you know. So but that is how we learn. You have to tell them that this is where you went wrong and this is how you can improve going forward'.*

II1/MT1/PG139/L307: *'So when you give them something, even from their peers. That is when I ask them to give critical but encouraging feedback.*

II2/MT2/PG137/L345-346: *'Then I want them to talk about and I want to see if they are able to pick up on their flaws if there are any or maybe the best methods. Or if the methods they used were effective enough to achieve their objectives'.*

There are a number of possible reasons for this. First, I would argue that it because of the nature and set-up of the student practicum. In the current system, student teachers mostly engage in large groups of about 12-15 with the mentor teachers about lesson planning and teaching. This is partly because of the set-up, partly because teachers are relatively new to the ideas of mentoring and partly because teachers tend to focus on the aspects that they are most comfortable with – such as lesson planning. As most of teachers themselves struggle with taking feedback from their peers or a development practitioner, they may tend to avoid this part of the conversations with students, despite Hudson (2007; 2013) arguing that *feedback* is one of the core aspects mentoring. I believe that much more in-depth training for the teachers and then the students is required if this is to improve. As Bullough and Draper (2004) argue, mentor teachers, student teachers and university supervisors need to understand their roles and these roles must be communicated in order to enhance the practicum experience for student teachers.

5.3.1 Student teacher's experiences regarding the mentor-mentee relationship

Similarly, literature by Hudson (2006) suggests that student teachers are able to learn during the practicum in learning environments conducive to the development of particular skills and knowledge. Such an environment is a place where they can learn through observing the mentor teacher teach, engage in discussions and communicate effectively. Hudson (2006) further outlines desirable mentor teacher attributes, required by student teachers of their mentor teachers. For instance, student teachers thrive in environments where they have supportive mentors, are comfortable with talking to the mentor and where the mentor teacher is an active listener and instils positive attitudes and confidence in the mentee. There is evidence of this in this study with one of the students mentioning how interactions with the mentor teachers gave her confidence to teach.

FG2/S9/PG138/L274: '*We learnt a lot from the teachers. It gave us confidence'*

FG2/S8/PG137/L248: *'She creates a space where we can be confident to say I like this or I did not like this'*

However, there are far too few examples of this nature, which points to limitations in the current system. For many students much of their interactions with their mentor teacher are only during lesson plan discussions and feedback sessions, limiting their ability to develop as reflective teachers. This is particularly problematic because it suggests that majority of the students do not benefit form meaningful interactions with the mentor teacher.

The data also shows that many students have difficulty opening up to the mentor teacher to tell them what they are struggling with and where they need additional assistance. This could be due to several factors such as the large student numbers in the classroom, insufficient time for mentoring, miscommunication between the mentor teachers and university lecturers and mentors expectations, the uncertainty on the part of the mentor teachers about their mentoring role and the differing mentoring practices in the teaching school. The following extracts from students speak to these issues:

FG1/S1/PG132/L76-78: '*So sometimes it does become difficult to expand our lessons because its' just like we feel restricted in a sense and are not able to tell this to the teacher'.*

FG1/S4/PG133/L117-120: *'Other times the teachers will be like you guys need to improve here and here. The next time they will be like no, after that you guys should change. Then you ask yourself, where are we now'?*

FG1/S6/PG134/L148-150: *They said we can also teach the remainder. Then when we put it in our lesson plan, they told us we're not allowed to do that. So were confused.*

5.3.2 Difficulties experienced by mentor teachers and student teachers regarding the practicum

From the sections 5.2 and 5.3. it is apparent that there are a number of challenges associated with the current practicum model. The expectation is that the practicum should provide experiences that develop student teachers PCK and allow them to connect university coursework with school teaching. In turn the school setting should be a place where student teachers develop and enhance their teaching practice (Danielson, 2002) with the teaching school serving as a pedagogical laboratory (Loukomies, Petersen & Lavonen, 2018: Henning, Petersen & Petker, 2014). In the next sections, I will expand on the difficulties students and their mentors experienced.

5.3.2.1 *Large student numbers impact mentoring*

One of the factors contributing to the mentor teacher willingness/openness to mentor student teachers at the teaching school is the large number of students in the practicum groups. In the Sesotho classes students in each group range between 12 -15 students. In the IsiZulu class the numbers range from 15 - 19 students. The unevenness of this distribution is largely because students often prefer to be in a group of the language they are learning as part of their B Ed courses. The complexity of mentoring large groups of students can prove to be quite a difficult task. It is common for mentor teachers to feel anxious about mentoring because each student teacher is different and they all differ in content knowledge, attitude and professionalism (Hudson & Peard, 2005). Having up to 19 students in a group negatively impacts the teachers' mentoring task.

From my experience as mentor teacher at the teaching school, I have found that the large group of students made mentoring very difficult. It was almost impossible to involve all of them optimally because there were simply too many of them. Resultantly, we included them in the execution of lessons in a haphazard and rather unsystematic manner. This would more often result in only a few student teachers participating meaningfully with the learners. In the interviews mentor teachers also pointed this out and made suggestions for improving the practicum, an aspect which is being addressed.

II1/MT1/PG140/L324: *'They can rotate. They can come in on Monday or Tuesday, or any other day. As long as all the third year in that week, get an opportunity to teach. Currently there are too many of them in the group'.*

I support this and argue that student teachers observing and teaching in smaller groups could improve the quality of their interactions with the mentor teacher. Wang, Odell and Schwill (2008) report that student teacher's benefit from discussions about their observations in the classroom. However, if there are too many students in the classroom then the teacher might not always get the opportunity to interact meaningfully with all the students. Factors such as following the school timetable and curriculum demands to complete the curriculum further limits the time mentor teachers have with student teachers in the classroom. Student teachers too indicated that they did not like being in such large groups because it limited their interactions with the mentor teacher. Both groups felt that they had to make it work because it was a systematic issue, which they had no control over.

FG2/S8/PG137/L250: *‘Now when we are reflecting, we get a chance to say ok guys this is what went well. Even though there too many of us in the group’.*

FG1/S2/PG134/L187: *‘And it’s also difficult because we have had two cycles only. We’ve only had two mentoring sessions with the two teachers. So it’s not enough time really’.*

There have been numerous discussions upon concerns raised by mentor teachers and university lecturers in focus group meetings held at the school since 2011-2018, one of which was the number of students in the practicum groups. During this period, there was an average of 120 students in the B Ed Foundation phase cohort, which later rose to up to 140. This put an enormous amount of pressure on the practicum organisers to ensure that all students had ample time in the school to observe children and to teach and be mentored – having bigger groups meant that students were afforded at least four weeks to observe and teach. Much of the literature on mentoring does not really address issues of mentoring such large numbers of students in the classroom (Danielson, 2002 & Hudson, 2007) and both academic staff and mentor teachers are engaged in discussions about how to make the model workable. It is also part and parcel of the developmental nature of the practicum and the trial and error system of establishing a model in such a new type of school in South Africa. The large numbers also influenced the students’ ability to plan for the teaching of lessons effectively. For instance, students said the following in this regard:

FG2/S8/PG137/L249: *‘There are some people who do not participate in the actual planning of the lesson’.*

FG2/S8/PG137/L251: *‘Some group members are dominating in the planning and some do get a chance during the planning’.*

It is interesting to note that student teachers do not focus on other aspects related to mentoring other than the lesson planning. None of them expressed how being in groups is an advantage, by for instance referring to how they have to learn to take shared responsibilities for the tasks they are required to do, including preparing the lesson plan, making teaching aids and any other task related to mathematics lesson. The large groups were seen more as an obstacle with students only focusing on the negative experiences they might have had with some of their peers. Some students even went to the extent of saying that they feel more empowered when they engage in the practicum at WIL schools because then they work individually with one mentor teacher.

II3/MT3/PG142/L408: *'I think there should be more interaction between mentor teachers and students'.*

5.3.2.2 Expected PCK not modelled by mentor teachers

There were also concerns raised by students about how what they learn in their university coursework and the expectation to see pedagogy being modelled by the mentor teachers at the teaching school is not always realized. The expectation underpins that university lecturers would work collaboratively with mentor teachers to ensure that their have shared goals and methods for working with student teachers. Grossman, Place, Martin and Valencia (2009) refers to this kind of relationship as a triad of members consisting of the university lecturers, mentor teachers and student teachers. These authors also argue that each member's role should be clarified in order to avoid a clash between what is expected or intended. There seems to be some misalignment between the university staff expectations and the mentor teachers' roles, which is being picked up by students who describe this as follows:

FG1/S2/PG133/L125: *'Sometimes the advice given to us by the mentor teacher will contradict what we are learning at the university'.*

FG1/S2/PG133/L132-134: *'Yes, and which I actually don't understand because it's one. So you would expect what we are learning to be similar to what the mentor teachers want. It confuses us as groups and that's how we lose marks.*

I would argue that if a shared understanding about the roles and responsibilities of the student teacher, mentor teacher and university lecturer does not exist then there will be confusion. Ultimately, this has an impact on the mentoring student teachers are exposed to and could affect their teaching practice. One of the biggest issues is that student teachers do not observe mathematics pedagogy they learn about in their university coursework being practiced in the school classroom. It may be due to a number of limitations of the current system – including the mentor teacher being stuck in one way of teaching, being unaware of what student teachers are learning at university (although student course guides are shared with school staff) or it could be that mentor teachers need more in-service training to equip them with up-to-date pedagogies for mathematics.

5.3.3 Mentors using a systematic process of guiding students

Despite the difficulties, it seems as if mentors at the teaching school follow a systematic process of mentoring student teachers informed by the university protocol documents developed by the practicum task team in 2015. The protocol documents for mentoring are generic to all subjects and not subject specific as a first step to getting teachers at the school accustomed to mentoring – they are thus a starting point for fostering discussions between the mentor teacher and the student teachers. However, one of the mentor teacher spoke about how the use of the same mentoring tool was becoming tedious because they already know what to expect.

II3/MT3/PG142/L392: *'There is a template which is very generic that we normally use. It becomes some sort of a habit. It becomes very easy to answer those questions'.*

Another mentor felt that although the process of mentoring was systematic, there was a lack of collaboration between the mentors and student teachers. In my view, student teachers learn optimally in the practicum when they have shared responsibility for defining their needs and setting their goals with the mentor teacher. This is a hallmark of successful mentor teacher-student teacher collaboration. In the Finnish teaching school, for instance third year students set aims to assist them to develop readiness for collaborative planning and co-teaching in primary school education thus improving their PCK (Lavonen, Henning, Petersen, Loukomies & Myllyvitta, 2018). Similarly, one of the specific practice aim for South African third year students is for student teachers to participate in group planning and work collaboratively to develop their PCK (Lavonen et al, 2018) argue that these outcomes are attainable despite the difference in context between South African and Finnish third-year student teachers if the practicum works as it is supposed to.

II3/MT3/PG143/L411-412: *'So if we can have that collaborative type of mentoring. Where in the morning you can start by declaring your intentions for your lessons, your needs and your expectations'.*

II3/MT3/PG143/L413: *'Also try to clarify the methods that you will be using that they can then be able to see the type of method'.*

5.3.3.1 Mentor teachers mentoring role in preparing student teachers to teach

One of the most important aspects of the mentoring process, assisting student teachers in developing their teaching practice, came out clearly in the data. Hudson (2013) argues that mentoring provides the mentor and mentee opportunities to engage in pedagogic discourse and reflective thinking. In this study, student teachers are afforded the opportunity to engage in two mentoring sessions. One occurs before they teach the lesson and the other happens after they have taught a lesson. The pre-teaching mentoring session is meant to help student teachers prepare their lesson plan with the guidance of the mentor teacher. Student teachers can engage with the mentor teacher to seek advice about the different teaching methods the can employ to teach a particular mathematics concept. Student teachers report on this process as a useful step in the planning phase of their lesson. They say the following:

FG1/S2/PG133/L121-122: *'The mentoring sessions were all helpful as in guiding us on what to do with the lesson. Giving us the topic, giving us pointers'.*

FG1/S3/PG132-133/L98-101: *'Yes, I find them very helpful because you now know what is expected of you. Rather than going there and wondering where you are going to start. They give us direction. Every time you go to a mentoring session, you grasp something new that you didn't know'.*

Mentor teachers discuss with students how they should prepare for their lesson/s and get clarity about concepts they will be teaching. Here students report that mentors teachers guide the creative process of the lesson planning. This is in line with the arguments of Leinhardt (1993) who contends that mentoring is a process where expert teachers (mentors) use their skills to help develop the skills of novice teachers. The creative process includes discussions about the topic student teachers are going to teach, possible teaching methods they could use, classroom management tips and the overall aim and specific outcomes they want to achieve at the end of the lesson. The findings in the data suggests that student teachers feel that they benefit immensely from the pre-lesson mentoring because it provides clarity and sets expectations for the mentor teacher of kind of lesson they are going to teach the learners.

FG2/S8/PG136/L240: *'So I feel like she has more to do with the creativity of the lesson. She does guide us in the creativity and methods of actually teaching the mathematics'.*

FG2/S9/PG137/L245: *'So they do give us space to be a little bit more creative and come up with new things, maybe what she never thought of'.*

After teaching the lessons, in a second phase of mentoring, student teachers receive feedback from their mentor teacher. Hudson (2007; 2013) in the five-factor model for mentoring describes *feedback* as one of the core aspects mentoring. Feedback includes discussions about student's PCK (Shulman, 1987) with much effort put into getting students to reflect on their teaching. Mentor teachers spoke about how they used a checklist in the post lesson mentoring session.

II1/MT1/PG139/L298: *'Well we do have a rubric that we use, but before I use that rubric I give them the opportunity to talk about the lesson and what they observed and what they liked and disliked'.*

II3/MT3/PG142/L391: *'Ummmh, after the presentation what I normally do is we reflect on the lesson and there would be some few questions that I would ask'.*

II2/MT2/PG140/L344-345: *'Ok first of all, I want to hear from them how they think they delivered the lesson. Then I want them to talk to and I want to see if they are able to notice their flaws if there is any or maybe the best methods'.*

Table 5.3.3.1.1. Consists of a sample of questions taken from the university protocol documents that mentor teachers use to ask student teachers after they have presented their lessons.

Table 5.3.3.1.1 Post-lesson mentoring questions for student teachers

1. How did you plan the lesson?
2. How was work shared among the group members?
3. What was the pedagogic purpose of using teaching aids?
4. What is purpose of assessing learners in the class?
5. Describe the challenges you encountered in working together as a group.
6. Describe what you learned the most from this teaching experience that would useful in the future.
7. If you were given the opportunity to plan the lesson again, which aspects would you keep and what would you do differently?
8. What did you specifically enjoy about the lesson?
9. What did you dislike about the lesson?
10. Was the lesson delivered as the group had planned?

Both the rubric and the questions serve as a good starting point for teachers to engage students in the mentoring process. However, the mentors' felt that it constrained student learning as they have become familiar with the checklist and already know what to expect. One mentor suggested that the set of questions should only be used as a starting point for mentoring and that students should be encouraged to give more critical responses about the development of their PCK. In one of the mentor teacher's responses, she argues that mentor teachers should expand these questions based on student teacher's performance in teaching the lesson. This was the intention of the set of questions but it seems as if teachers see it as a fixed template.

II3/MT3/PG142/L392: *'There is a template which is very generic that we normally use. It becomes some sort of a habit. It becomes very easy to answer those questions'.*

Hudson and Sempowicz (2012) argue that mentoring should elicit and encourage reflective thinking. In this way, student teachers will always have a new perspective about their PCK. This could imply that they could apply the very same questions in a different way each time because they would be teaching different mathematical concepts. This is important to consider because student teachers engage in mentoring in pre-lesson phase and in the post-lesson phase. These two sessions allow the mentor to interact with student teacher without the interruption of learners in the classroom. During the normal classroom time, it is difficult for student teachers to engage in critical discussions with the mentor teacher because the focus is more on the learners.

The purpose of pre-lesson and post-lesson mentoring is to enhance student teachers conceptual understanding of the subject specific pedagogical content knowledge development – in the case of this research the mathematical concepts they teach. The expectation is thus that while student teachers are being mentored, they should gain better insights about their subject specific PCK. In this study, the expectation would be that mentoring would enable the process of reflection about students teaching methods and ways to improve how they teach mathematical concepts. Mentor teachers views were that student teachers have trouble in conceptually understanding of the mathematics concepts they were to teach.

II3/MT3/PG141/L378-379: *'When it comes to the conceptual knowledge. They are lacking and I don't see them achieving that without being mentored or shown to say this is what you actually need to say or teach'.*

II1/MT1/PG139/L312: *'We want them to get to a point where they critically think about their methods and why they altered them as they teach'.*

5.4 There is value to student teachers having different mentor teachers over the course of their studies

Over the course of the four-year B Ed programme, student teachers engage with different mentor teachers and observe the pedagogies of these teachers. Hudson (2007) argues that student teachers desire certain mentor teacher attributes and may not necessarily find all these attributes in one particular mentor teacher. These attributes were discussed in section 5.2 of this chapter. In this study, the practicum forms part of their programme that is aimed at helping them integrate theory (from coursework) and practice. Sedumedi (2014) argues that mentoring plays a crucial role in developing student teachers' teaching practice and overall professional development. In addition, Fairbanks, Freedman and Kahn (2000: 103) define mentoring as 'complex social interactions that mentor teachers and student teachers' construct and negotiate for a variety of professional purposes and in response to the contextual factors they encounter'. In this section, I will discuss student teachers perspectives of the value of having different mentor teachers including their experiences of mentoring in the teaching school and during WIL. I will also discuss how the lack of training for mentor teachers can influence student teachers' PCK development negatively.

Student teachers find value in mentoring when they are able to collaborate with their mentor teachers (Smith, 2007). Collaborative mentoring is a process that involves the mentors working with student teachers with the aim of helping students develop holistically as teachers (Smith, 2007). Mentor teachers in turn benefit by reflecting on their current teaching practices and (hopefully) seek ways of improving these practices. The design of the B Ed course in many universities is structured in such a way that it enables student teachers to engage with different mentor teachers (Danielson, 2002; Sedumedi; 2014). However, the B Ed course at the institution where this study was conducted is unique. This is because student teachers have access to a teaching laboratory (also known as a 'teaching school') where they could learn about teaching in a model environment. However, the idea of a model school is not always evident in teacher practices and school process and this impacts student teachers' development.

In addition, students also have mentor teachers at WIL schools and they tend to compare the type of support and guidance they get during the two different practicum periods.

5.4.1 Teaching methods observed by student teachers during the practicum

In this section, I will be discussing the teaching methods, which student teachers observed from their mentor teachers at the teaching school. These methods include group work and question and answer methods. Student teachers noted these teaching methods as interactive teaching methods, used by the mentor teachers. From the student teachers response I would argue that they are exposed to and learning that language is an important part of mathematics teaching and learning. Whether or not students are observing these methods to the extent of improving learner’s problem-solving skills, reasoning and understanding will be unpacked as each teaching method is discussed. The relationship between these two methods will also be discussed.

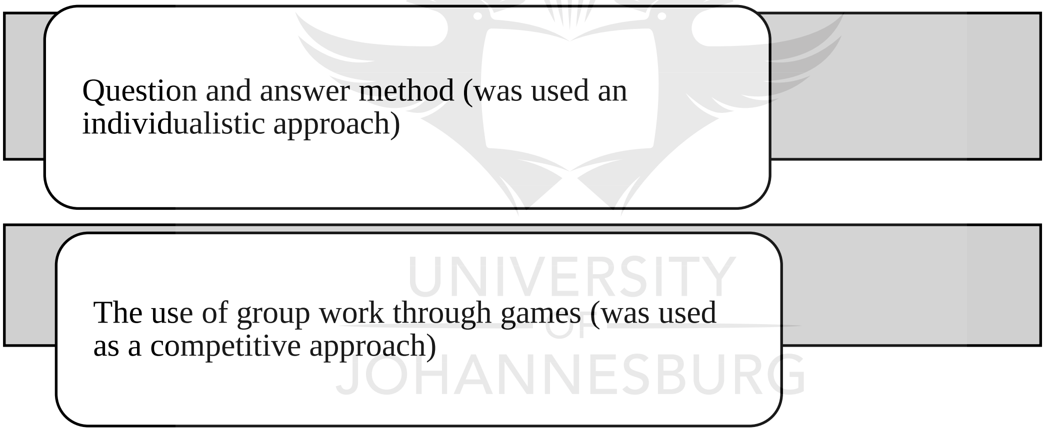


Figure 5.4.1.1 Common teaching methods observed by third year students and used by the mentor teachers at the teaching school

5.4.1.1 The use of the question and answer methods at the teaching school

Student teachers reported on the prevalence of the question and answer method during mathematics teaching. Student teachers views about the use of this method were limited to the practical use of the method in mathematics teaching in asking learners direct questions, which were not open-ended most of the time. Their responses suggested that they themselves had limited knowledge about the effective use of such a method. In the following extracts, two of the students provide vague responses about this method. Even when probed the students could not articulate the limitations or advantages of using this method.

FG1/S1/PG132/L54: *'Questioning and answering is also very important for the learners'.*

FG2/S10/PG136/L219: *'Yes, you will never know if the child knows what you're talking about, unless they ask you questions and they say it back. Or when you ask them question, they say back what you were asking'.*

In their attempts to articulate how this method was used in the respective classrooms, their views were limited to its use as a method used to initiate discussions between the teacher and the learner. Darwish (2012) argues that the bases of using this method is usually when learners give responses or ask in order to seek clarity. Furthermore, the teacher can use the method as a way of eliciting learners' prior knowledge of the concept. Alternatively, it can be used to assess if learners have understood the mathematical concept. Mercer and Sams (2013) report on the importance of distinguishing characteristics of a teaching method such as question and answer from real dialogic teaching. Real dialogic teaching entails using language as a teaching method to improve learner's reasoning, understanding and problem-solving skills (Mercer & Sams, 2006). Asking questions can be used as method to implement dialogic teaching but it is not dialogic teaching on its own.

The problem that I argue here is that student teacher's responses about their observations of this particular method are not reflective of true dialogic teaching. Their responses about how the mentor teacher used this method was articulated in the following way: Firstly, the mentor teacher would ask the learners questions about a concept and the learners should give the correct answer. Secondly, students only observe learners answering correctly or incorrectly. There is no evidence in the data, which suggests learners were asked follow up questions to the learners' response. Lastly, student teachers could not explain the process of using language through discussions as means of understanding the learners reasoning because they did not observe similar practices from the mentor teachers. I would conclude that the way the question and answer method was used at the teaching school does not develop dialogic teaching skills such as problem solving, reasoning and understanding.

5.4.1.2 *Student teacher's perceptions of mentor teachers using group work at the teaching school*

Student teachers observed that group work was another favoured method used by the mentor teachers. Student teachers explained that the mentor teachers encouraged the use of group work as an effective strategy for engaging learners and accommodating the large student numbers in the groups. Student teachers would all be assigned to a specific group of learners to ensure that they participate in the lesson. However, Johnson, Johnson and Smith (1998) argued that not all group work leads to cooperative learning. In essence, the nature of these tasks leads me to question how the teachers conceptualize group work as a method and the kind of knowledge they are transferring to student teachers. In the following extracts, the mentor teachers encourage student teachers to use group work as a teaching method and furthermore, they encourage students to use other methods as well if the group work is unsuccessful.

II1/MT1/PG139/L302: ***'****We talk about group involvement in the group work; we talk about the body of the lesson and whether the concept was understood by the learners'.*

II2/MT2/PG140/L342: ***'****For example, even group work is also important but not all the time. So they can use a variety of methods'.*

Based on the mentor teachers' responses, I can conclude that there is a lack of understanding regarding what the essence of group work is to yield cooperative learning outcomes. Johnson et al (1998) highlight three key approaches in group work. These include the competitive approach where learners compete with each other in the group. The individualistic approach involves learners working as individuals in a group and being assessed as individuals. They might have been put in groups so that they can share resources. The cooperative approach fosters positive interdependence among the members of the group (Johnson et al, 1998). This means that the learner can achieve his or her learning goal if the other group members achieve the goal as well. This is quite an uncommon approach to learning. Many teachers and students often use group work as a strategy to group learners together but not allow learners to talk and engage for the purposes of problem solving. The lack of this kind of evidence in the data strongly suggests that learners are merely put in groups as a measure of reducing the workload on teachers. The real essence of group work in the form of cooperative learning is unknown or not understood by mentor teachers at the teaching school.

On the other hand, student teachers might have been taught this concept as part of their methodology coursework but they are not seeing the intended purpose of cooperative learning in the group work activities at the school. They are also not implementing what they learn at university. This could weaken their PCK because they are more likely to practice and replicate the method in the manner the teachers to it. The data does not show any evidence of mentor teachers making the thinking (underlying philosophy) which informs their teaching methods explicit for student teachers (Brown, Collins & Holum, 1991).

5.4.1.3 Mentor teachers' perceptions of student teacher's using group work at the teaching school

Mentor teachers also reported that student teachers liked using group work. In one of the mentor teachers discussion she allude the use of games in teaching mathematical concepts. In her explanation, she emphasized the need for group work to be used for developing conceptual understanding and to allow learners to problem solve. Much like in cooperative learning, learners should engage with one another and ensure that the individual needs of all the group members are met in order to achieve a collective goal (Johnson et al, 1998). It is important to note that the ideal for the current practicum model was to foster cooperative learning because student teachers are required to teach in groups. In section 5.2.of this chapter I discussed how the challenges with the large groups of students affected student teacher's practicum experiences. With that said, it is still the responsibility of the mentor teacher to show the students how to use cooperative learning strategies for working and teaching together as a group. In the following extract, the mentor teacher provides an example of how student teachers implemented a group task.

II3/MT3/PG141/L372-373: *'You know when they reach the fourth year level they try to come up with some sort of activities like a play, games mostly. But you find that mostly in those games they are missing the teaching part of it.*

The mentor teachers' response could suggest that student teachers do not understand the purpose of group work. In this example, a game was used to teach a particular mathematical concept but the teacher responded by saying that there was little evidence of conceptualizing any mathematical concept. This could suggest that the intended purpose was not rooted in developing conceptual understanding of the mathematics concept. Student teachers most likely did not allow the learners to problem solve or engage in meaningful discussions about mathematical concept development. My sense is that when learners were playing the game the focus or approach was competitive in nature. Learners were more likely wanting to finish the game first, compete against each other within their respective groups and secondly, compete with learners in other groups. Hence, there was little teaching and understanding of the concept. The mentor teacher's response suggests that learners were rushed or directed into the procedure of playing and completing the game. The mentor teacher further indicated that student teachers need to be guided in teaching for understanding and engaging learners in problem-solving tasks. I argue that the mentor teachers' response is similar to the ideas and values, which inform student teacher's being mentored to incorporate cooperative learning in their group work tasks. In the following extract, the mentor teacher reports on how conceptual understanding of group work can be achieved.

II3/MT3/PG141/L378-379: *'When it come to the conceptual knowledge in their teaching methods, they are lacking and I don't see them achieving that without being mentored or shown to say this is what you actually need to say or teach'.*

Furthermore, within the group work students report that learners often group learners according to their ability groups. The reasoning behind this is that the stronger learners can work faster and be given enrichment activities and the teacher can work more intensely with the weaker learners.

FG1/S2/PG132/L57-61: *'She had the group with stronger learners and a group with not necessarily weaker learner, but learners who take longer to grasp the concept. That worked out because when she teaches the slower group, there are no learners rushing or getting bored because she is explaining the concept a few times or using different methods to help them'.*

5.4.2 Student teachers impressions of their teaching school and WIL mentor teachers

Student teachers responses about mentoring can provide some insights about the quality of their mentoring experiences. Student teachers' views about mentoring were not coherent and consistent. This would then lead me to question the difference in their mentoring experiences. From my own experience as a mentor teacher at the teaching school, I know that mentor teachers received substantial developmental opportunities about teaching mathematics and other subject areas as well. However, there was not much development or training concerning mentoring. I am of the view that this could be a contributing factor to the inconsistency in mentoring because each mentor approaches mentoring in manner they think best. However, Collins, Brown and Holum (1991) argue that mentoring is the process, which enables the student teacher to understand the teachers' cognitive process concerning teaching in a particular way. This did not occur optimally in this sample of participants. In the following extract, the students' response suggests that the mentoring sessions at times do not create a clear map for students in helping them link their university coursework with practice and they are often left feeling very confused.

FG1/S2/PG133/L124: *'Sometimes the advice given to us by the mentor teacher will contradict what we are learning at the university. Then we are left confused'.*

The extract above could suggest that there is a disjuncture in communication between the mentor teachers and the university lecturers. Students sometimes do not understand how the mentor teachers' teaching practice does not connect to the university coursework hence the confusion. Literature by Danielson (2002), Hudson (2007), Hudson and Sempowicz (2011) illustrates that good teachers are not necessarily good mentors. Teachers at the teaching school have to be good mentor teachers in order to help student teachers develop and improve their PCK. Therefore, a mentor in a teaching school requires consistent training in mentoring because they cannot mentor without knowing what the process of mentoring entails. More often, the mentor teachers' role at the teaching school is limited their role to mentoring in the form of assessing student teacher's lessons instead of assisting student teachers in developing professionally as prospective teachers (Hudson & Peard, 2005).

Student teacher's responses suggest that mentor teachers may not be fully aware of their roles in assisting student teachers integrating university coursework with teaching practice. Grossman et al (2009), argues that the roles of all triad members (mentor teachers, student teachers and university supervisors) need to be understood to ensure that student teachers develop and benefit from the practicum. I am of the view that mentoring should enhance the student teachers PCK (Shulman, 1987). They take part in the practicum to practice how to teach and mentoring is an avenue of ensuring that they learn from best practices and that student teachers are guided accordingly. As a result, during the practicum their PCK is reflected in their teaching methods because it is when they need to implement their content knowledge and their pedagogical knowledge. The mentor teacher becomes important for mediating between the university content (theory) and student teachers' practice. However, student teacher's responses suggest that mentor teachers at the teaching school are unable to make their thinking explicit for the students.

My concern is that student teachers were unable to share such experiences with their about their mentor teachers. This is concerning because a teaching school is where student teachers are supposed to learn from best practices. It may be that mentor teachers do not always effectively communicate their expectations from students regarding teaching a particular mathematical concept. Fairbanks, freedman and Kahn (2000) argue that the interpersonal relationships are constructed and negotiation is an important aspect of maintaining this relationship. A student repeated the following:

FG1/S4/PG132/L86-90: *'Like she said, I feel that they're (the mentor teachers) are not allowing us to do things in a way that we would like to do them. We are mostly limited to doing things in the method they would want us to use. Like what we do is always going to be criticized as to say that our methods are always going to be criticized'.*

Based on the above I would argue that student teachers feel that they sometimes feel restricted about employing certain teaching methods and this could affect the development of their mathematical PCK. This particular student felt that they are more restricted at the teaching school because the mentor teacher does not allow them the latitude to implement lessons in ways they want. Hudson and Sempowicz (2012) argue that during mentoring it is often not easy for student teachers to let go of their teaching experiences they were exposed to or their perceptions of how teaching should be. Mentoring is a process, which is aimed at helping them critically reflect on how they think mathematics concepts should be taught and learn new methods of teaching because the way they were taught might not necessarily be appropriate. This kind of tension is thus normal in a study of this nature.

In the second focus group, there was consensus about the improvement of their mathematical PCK at the teaching school. They reported observing good teaching practice and learning about innovative teaching practices. One particular student reported on how he/she feels that they have learned a lot from the practicum experience at the teaching school.

FG2/S9/PG138/L 274-275: *'Here at the teaching school we see things that are not done anywhere else. So you think if lana (here) they are doing so much and I have learned so much'.*

I found it quite interesting to note that even if student teachers are all allocated time at the teaching school their experiences are not the same. In the second focus group, the student claimed to have observed good teaching practice because the teacher exposed them to innovative teaching practices. The general view in this particular group was of a positive mentoring experience from the different mentor teachers at the teaching school. Students interpreted these experiences as good mentoring.

FG2/S8/PG137/L262: *'In grade 1 we were doing English, now were doing maths with grade 2 learners. So were learning things we did not know about teaching maths'.*

FG2/S7/PG137/L265-266: *'Even though you see that, the teacher's here have a connection because even the way they teach is not the same. They have the same kind of vision or the same kind of way of doing things'.*

The evidence from this data shows that student teachers are observing consistent teaching practices at the teaching school. However, student teachers have different experiences of mentoring within the teaching school.

5.5 Conclusion

The overall impression of the teaching methods observed by student teachers suggest that student teachers are not necessarily observing best practices at the teaching school because there is much difference between what they observe at WIL schools. A laboratory school like the teaching school should allow for more experimentation with teaching methods (Gravett & Ramsaroop, 2015). More effort is required from the teaching school mentor teachers to incorporate cooperative learning and dialogic teaching are effective methods because they with student teachers in groups. Such methodologies will benefit both the learners and improve student teacher's PCK. Student teachers perceptions about mentoring is largely, influenced by their experiences with their mentor teachers. The data in this study shows that student related better with their mentors when they feel like they have established a good working mentor-mentee relationship. In this particular case, only a minority of students benefit from this kind of relationship.

Mentor teachers concerns with establishing such a relationship are affected by the large numbers of students in the groups. A common finding among students and their mentors was recognising the importance of mathematical content knowledge as a pre-requisite for mathematics teaching. Along with this was the importance of using innovative teaching aids to enhance their PCK. Both the mentor teacher and student teachers showed limited understanding of the mathematics curriculum. They provided vaguely articulated the theoretical stance that informs their teaching. Furthermore, mathematical thinking processes and mathematical big ideas were not expressed well. This could suggest that neither the students nor their mentors understand them in depth or that they were not probed sufficiently to articulate them well.

5.6 Limitations

This study consisted of a small sample of student teachers and mentor teachers within the teaching school. Therefore, the findings could not be generalized to the overall practicum experiences of all the student teachers from the first year to the fourth year cohorts in other universities. This is because the quality of the practicum experiences of student teachers often influences the development of student teacher’s PCK (Hudson, 2007). Furthermore, this is evident in the findings of this study. Another limitation in this study was the lack of other forms of examples of evidence in the form of artefacts that contribute to the data collection process. The data collection methods were limited to individual and focus group interviews but could have also included rubrics of student teacher’s lesson plans with written comments from the mentor teacher. Particularly because this information is available from the practicum coordinators. In addition, video recordings of the mentoring sessions could have provided in-depth empirical evidence of the mentoring practices between the mentor teachers and the student teachers. It could have also provided more detail about the mentor-mentee relationship dynamics in both classrooms.

5.7 Recommendations

I would recommend that a study such as this one to be conducted with more student teachers within the university to gain better insights into the experiences of all student teachers for improving the practicum at the teaching school. This can provide better insights of mentoring programmes in other universities in South Africa. Studies such as this particular study can contribute to strengthening work integrated learning (WIL) experiences of student teachers during the practicum. Secondly, I would recommend that practicum groups should only consist of five to seven students per group. This is to strengthen the mentor-mentee relationship between the mentor teachers and student teachers at the teaching school. Student teachers can benefit and demonstrate better understanding of the teaching of mathematics during the practicum if the mentor-mentee relationship is established. As discussed in the literature by Hudson (2013), Danielson (2002) as well as Bird and Hudson (2015) on the importance of student teachers forming professional working relationships during the practicum. Lastly, I would recommend more training for mentor teachers (specific to mathematics teaching) at the teaching school because continuous professional development for mentor teachers can enhance the overall mentoring experience for student teachers. In addition, communities of practice between university lecturers and mentor teachers can improve the communication between them.

REFERENCES

Allen, D., & Oliver-Hoyo, M. (2006). The Use of Triangulation Methods in Qualitative Educational Research. *Journal of College Science Teaching.*

Allen, J. M., & Peach, D. (2007). Exploring connections between the in-field and on-campus components of a pre-service teacher education program: A student perspective. *Asia-Pacific Journal of Cooperative Education,* 8 (2), 136 - 151.

Allen, J.M., & Wright, S.E. (2014). Integrating theory and practice in the pre-service teacher education practicum. *The Journal of Teachers and Teaching*- theory and practice, 20 (1), 112-134

Anderson, M. H. (2006). How can we know what we think until we see what we said?: A citation and citation context analysis of Karl Weick's The Social Psychology of Organizing. *Organization Studies*, *27* (11), 1675-1692.

Askew, M. (2012). Transforming primary mathematics. Routledge.

Babbie, E. and Mouton, J. (2015). The Practice of Social Research. South Africa Oxford University Press, Cape Town.

Bakker, A., Smit, J., & Wegerif, R. (2015). Scaffolding and dialogic teaching in mathematics education: Introduction and review. *Mathematics Education*, 47, 1047–1065.

Ball, D.L., Thames, M.H., & Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education*, 59 (5), 389–407.

Barab, S.A., & Kirshner, D. (2001). Guest editors' introduction: Rethinking methodology in the learning sciences. *The journal of the learning sciences*, *10* (1-2), 5-15.

Bird, L., & Hudson, P. (2015). Investigating a model of mentoring for effective teaching. *Journal of Teaching Effectiveness and Student Achievement, 2* (2), 11-21.

Beutel, D., & Spooner-Lane, R. (2009). Building mentoring capabilities in experienced teachers. *The International Journal of Learning*, *16* (4), 351-360.

Bohman, J. (2005). Critical Theory. Stanford Encyclopedia of Philosophy. Stanford Centre for the Study of Language and Information. Retrieved from the internet on the 02/02/2019 from: http://plato.stanford.edu/entries/critical-theory/:

Borko, H., & Mayfield, V. (1995). The roles of the cooperating teacher and university supervisor in learning to teach. *Teaching and Teacher Education*, *11*, 501-518.

Botha, R.J. (2010). Outcomes-based education and educational reform in South Africa. 361-371. Published online 10 Nov 2010.

Bowie, L. (2014). Initial Teacher Education Research Project: Report on mathematics courses for intermediate phase student teachers at five universities, JET Education Services, Johannesburg.

Bowie, L., & Frith, V (2006). Concerns about the South African Mathematical Literacy curriculum arising from experience of materials development. *Pythagoras,* 64. | DOI: https://doi.org/10.4102/pythagoras.v0i64.96

Brookfield, S.D. (1995). Becoming a critically reflective teacher. San Fransisco, CA:Jossey-Porfilio, B. J. Analysis in the Core Content Areas. *English Journal*, *98* (6), 5-22.

Brophy, J., & Good, T.L. (1986). Teacher behaviour and student achievement. In M.C. Wittrock (Ed.), Handbook of research on teaching (3rd ed.). New York: Macmillan.

Bullough Jr, R. V., & Draper, R. J. (2004). Making sense of a failed triad: Mentors, university supervisors, and positioning theory. *Journal of Teacher Education*, *55* (5), 407-420.

Chetty, M.S. (2015). Teacher's understanding and experiences of the Gauteng Primary Schools Literacy and Mathematics Strategy. Published Masters dissertation. University of the Witwatersrand, Johannesburg, South Africa.

Collins, A. (1992). Towards a design science of education. In E. Scanlon & T. O'Shea (Eds.), New directions in educational technology,15-22. Berlin: Springer.

Collins, A., Brown, J.S., & Holum, A. (1991). Cognitive Apprenticeship: making thinking visible. Journal of the American Federation of Teachers, 15 (3), 11-39.

Creswell, J.W. (2007). Qualitative inquiry and research design. Choosing among five approaches (2nd ed.). Thousand Oaks, CA: Sage.

Crowther, D.T., & Cannon, J.R. (1998). How much is enough? Preparing elementary science teachers through science practicums. Paper presented at the Annual Meeting of the Association for the Education of Teachers of Science. Minneapolis, MN.

Curriculum and Assessment Policy Statement (2011). Department of Education. South Africa.

Danielson, L. (2002). Developing and retaining quality classroom teachers through mentoring. University of South Dakota.

Darling-Hammond, L. (2006). Powerful teacher education: Lessons from exemplary programs. San Francisco, CA: Jossey-Bass.

de Vaus, D. A. & de Vaus, D. (2001). *Research design in social research*. Sage.

Department for Education (DfE). (1993). Initial teacher training for primary schools: New criteria for courses. (Circular 14/93) (London, DfE).

Department of Education, South Africa. (2003). *National Curriculum Statement Grades 10 – 12 (General). Mathematical Literacy.* Retrieved February, 2006, from http://www.education.gov.za/content/document

Department of Education, South Africa. (2005a). *National Curriculum Statement Grades 10 – 12 (General). Learning Programme Guidelines Mathematical Literacy.* Retrieved February, 2006, from http://www.education.gov.za/

Department of Education, South Africa. (2005b). *National Curriculum Statement Grades 10 – 12 (General). Subject Assessment Guidelines Mathematical Literacy.* Retrieved February, 2006, from http://www.education.gov.za/

Dewey, J. (1904). The relation of theory to practice in education. In C. A. McMurry (Ed.), The relation between theory and practice in the education of teachers: Third Yearbook of the National Society for the Scientific Study of Education, part 1 pp. 9–30. Chicago: The University of Chicago Press.

Dhlamini, J. (2016). Enhancing learners' problem solving performance in mathematics: A cognitive load perspective. European Journal of STEM Education, 1 (11), 27-36. University of South Africa, South Africa.

Edwards, A., & Protheroe, L. (2004). Teaching by Proxy: Understanding how mentor teachers are positioned in partnerships. *Oxford Review of Education*, 30.(2). Taylor and Francis.

Feiman-Nemser, S. (2001). Helping novices learn to teach: Lessons from an exemplary support teacher. *Journal of Teacher Education*, *52* (1), 17-30.

Feiman-Nemser, S. (2003). What new teachers need to learn. *Educational leadership*, *60* (8), 25-29.

Fleisch, D. (2008). *A student's guide to Maxwell's equations*. Cambridge University Press.

Fonseca, K., & Petersen, N. (2015). Online supplementary mathematics tuition in a first year childhood teacher education programme. *South African Journal of Childhood Education, 4 (2), 98-121.*

Fonseca, K., Maseko, J., & Roberts, N. (2018) ‘Students mathematical knowledge in a bachelor of Education (Foundation or intermediate phase) programme’, in Govender, R. & Junqueira, K. (2018) *Proceedings of the 24th Annual National Congress of the Association for Mathematics Education of South Africa*, ISBN: 978-0-6399514-0-9, AMESA 2018 Long Paper, 25 – 29 June 2018 University of the Free State, Bloemfontein Campus, Free State, pp. 124-139.

Fritz, A., Ehlert, A., & Balzer, L. (2013). Development of mathematical concepts as a basis for an elaborated mathematical understanding. South African Journal of Childhood Education, 3. (1), 22-38.

Glaser, B. G., & Strauss, A. L. (1967). The discovery of grounded theory Strategies for qualitative research. New York Aldine De Gruyter.

Gibson, W. (2017). Constructing knowledge through social research: Debates in epistemology and ontology. In J. Swain (Ed). Designing research in Education: Concepts and Methodologies.

Graven, M., & Venket, H. (2008). Opening up spaces for learning: Learner’s perceptions of Mathematical Literacy in Grade 10. *Education as Change*, 12 (1), 29-44.

Gravett, S., Petersen, N., & Petker, G. (2014). Integrating foundation phase teacher education with a ‘teaching school’ at the University of Johannesburg. Education as Change, 18. 107-119.

Gravett, S., & Ramsaroop, S. (2015). Bridging theory and practice in teacher education: teaching schools- a bridge too far? *Perspectives in education,* 33(1), 131-146.

Gravett, S., & Ramsaroop, S. (2017). The potential of teaching schools in enabling student teacher learning for the teaching profession. *Journal of curriculum studies*.

Henning, E., Van Rensburg, W., & Smit, B. (2004). *Finding your way in qualitative research* (pp. 19-22). Pretoria: van Schaik.

Henning, E., Van Rensburg, W., & Smit, B. (2011). Finding your way in qualitative research. Van Schaik.

Hill, H.C., D, Loewenberg-Ball., & Schilling, S.G. (2008). Unpacking Pedagogical Content Knowledge: Conceptualizing and Measuring Teacher’s Topic Specific Knowledge of Students. Journal for Research in Mathematics Education, 39 (4), 372-400.

Hill, H.C., Rowan, B., & Ball, D.L. (2005) Effects of teachers’ mathematical knowledge for teaching on student achievement. *American Educational Research Journal*, 42 (2), 371–406.

Hobson, A. J., Ashby, P., Malderez, A., & Tomlinson, P. D. (2009). Mentoring beginning teachers: What we know and what we don’t. *Teaching and Teacher Education, 25* (1), 207-216.

Horkeimer, M. (1982). Critical theory, New York: Seabury Press; Reprinted Continuum: New York.

Hudson, P. (2007). Examining mentors’ practices for enhancing preservice teachers’ pedagogical development in mathematics and science. *Mentoring & Tutoring: Partnership in Learning, 15* (2), 201–217.

Hudson, P. (2013). Identifying desirable attributes and practices for mentees. Manuscript submitted for publication.

Hudson, P. (2013). Forming the mentor-mentee relationship. *Journal of Mentoring and Tutoring.*

Hudson, P., & Hudson, S. (2011). Converting theory to practice: University-school collaboration on devising strategies for mentoring pedagogical knowledge. *International Journal of Learning, 18 (*1), 1-14.

Hudson, P., & Peard, R. (2005). Mentoring for effective mathematics teaching. Paper presented at the Eight International Conference, Johor Bharu, Malaysia

Hudson, P., & Sempowicz, T. (2012). Mentoring preservice teachers' reflective practices to produce teaching outcomes. *International Journal of Evidence Based Coaching and Mentoring, 10* (2), 52-64.

Hudson, P., Usak, M., & Savran-Gencer, A. (2009). Employing the five-factor mentoring instrument: analysing mentoring practices for teaching primary science. *European Journal of Teacher Education*, *32* (1), 63-74.

Jansen, J., & Taylor, N. (2003). Educational Change in South Africa 1994 – 2003: Case studies in large-scale education reform.

Johnson, W.B. (2003). A Framework for Conceptualizing Competence to Mentor. Department of Leadership, Ethics, and Law United States Naval Academy. Ethics & Behaviour, 13 (2), 127–151.

Johnson, D. W., Johnson, R. T., & Smith, K. A. (2013). Active learning cooperation in the college classroom. Edina, MN Interaction Book Company.

Jones, M., & Ryan, J. (2014). Learning in the practicum: engaging pre-service teachers in reflective practice in the online space, Asia-Pacific Journal of Teacher Education, 42 (2), 132-146.

Korthagen, F. (2001). Teacher education: A problematic enterprise in linking practice and theory: the pedagogy of realistic teacher education. Mahwah, NJ: Lawrence Erlbaum.

Korthagen, F. (2004). In search of the essence of a good teacher: Towards a more holistic approach in teacher education. *Teaching and Teacher Education, 20*, 77–97.

Korthagen, F., Loughran, J.J., & Russell, T. (2006). Developing fundamental principles for teacher education programs and practices. Teaching and Teacher Education, 22 (8), 1020 – 1041.

Kreber, C., & Cranton, P. (2000). Exploring the scholarship of teaching. *The journal of Higher Education,* 71 (4), 476-495.

Kuzler, A., & Beihler, R. (2014). Examining mathematics mentor teachers' practices in professional development courses on teaching data analysis: implications for mentor teachers' programs.

Labaree, D. F. (2009, August). Education: Whither the common schools 'Panel held at the annual meeting of the American Sociological Association, San Francisco.

Lanier, J., & Little, J.W. (1986). Research in teacher education. In M. C. Wittrock (Ed.), Handbook of research on teaching (3rd Edition, 527–560). New York, NY: MacMillan.

Lannin, J.K., Webb, M., Chval, K., Arbaugh, F., Hicks, S., Taylor, C., & Bruton, R. (2013). The development of beginning mathematics teacher pedagogical content knowledge. Maths Teacher Education. Springer.

Laschke, C. (2013). Effects of future mathematics teachers' affective cognitive and socio-demographic characteristics on their teacher education in Germany and Taiwan', *International Journal of Science and Mathematics Education,* 11, 895–921.

Lave, J. (1988). The Culture of Acquisition and the Practice of Understanding. (Report No. IRL88-0007). Palo-Alto, CA: Institute for Research on Learning.

Lave, J., & Wenger, E. (1991). Situated learning: legitimate Peripheral Participation. New York: Cambridge University Press.

Lavonen, J., Henning, E., Petersen, N., Loukomies, A., & Myllyviita, A. (2019) A comparison of student teacher learning from practice in university-affiliated schools in Helsinki and Johannesburg*, European Journal of Teacher Education,* 42 (1), 4-18, Leinhardt, G. (1993). Weaving instructional explanations in history. British Journal of Educational Psychology. Published online: 13 May 2013.

Leinhardt, G., Young, K. M., & Merriman, J. (1995) Integrating professional knowledge: the theory of practice and the practice of theory, *Learning and Instruction,* 5, 401–408.

Lepper, M.R., & Greene, D. (1979). *The Hidden Costs of Reward.* Hillsdale, NJ: Erlbaum.

Lincoln, Y.S. (1995). Emerging Criteria for Quality in Qualitative and Interpretive Research, 1 (3), 275-289.

Lincoln, Y.S., & Guba, E.G. (1985). Naturalistic Inquiry. Newbury Park, CA: SAGE Publications. Mahwah, NJ: Erlbaum.

Livy, S., & Vale, C. (2011). First Year Pre-Service Teachers' Mathematical Content Knowledge: Methods of Solution for a Ratio Question. *Mathematics Teacher Education and Development*, 13 (2), 22-43.

Lowie, T., & Jorgensen, R. (2015). Pre-service teachers' mathematics content knowledge: implications for how mathematics is taught in higher education. *Teaching Mathematics and Its Applications*, 35, 202-215.

Loukomies, A., Petersen, N., & Lavonen, J. (2018). A Finnish model of teacher education informs a South African one: A teaching school as a pedagogical laboratory. *South African Journal of Childhood Education, 8(1)*, 593. https://doi.org/10.4102/sajce.v8i1.593

Luneta, K., & Olusola, A. (2015). Assessing the primary school mathematics in South Africa: Literature and teacher's perspectives. Published online: 284-260. Mahwah, NJ: Erlbaum.

Ma, L. (1999). Knowing and teaching elementary mathematics: Teachers' understanding of fundamental mathematics in China and the United States. Mahwah, N.J.: Lawrence Erlbaum Associates.

Machaba, F.M. (2016). The concepts of area and perimeter: Insights and misconceptions of Grade 10 learners. *Journal of the Association for Mathematics Education of South Africa*, 37 (1), 1-11.

Magano, M. D. (2011). The New Kind of a Teacher, to Handle the New Subject-Life Orientation, in a Township High School in South Africa. *Journal of Social Sciences*, *28* (2), 119-127.

Maharajh, L.R., Nkosi, T., & Mkhize, M.C. (2016). Teachers' experiences of the implementation of the Curriculum and Assessment Policy Statement (CAPS) in three primary schools in KwaZulu-Natal. Africa's Public Service Delivery and Performance Review, 4 (3):371-388.

Maykut, P., & Morehouse, R. (1994). Beginning qualitative research, a philosophic and practical guide. London: The Falmer Press.

Mays, H. (2005). Mathematical knowledge of some entrants to a preservice education course, in M. Coupland, J. Anderson & T. Spencer (eds.), *Making mathematics vital Proceedings of the 20th biennial conference of the Australian Association of Mathematics Teachers*, 43–52, AAMT, Adelaide.

Mbatsha, Z. (2013). Learners' perceptions of mathematical literacy in the Further Education and Training (FET) band in three selected high schools. Published Masters Dissertation. University of Forte Hare.

Mdutshane, V.N. (2006). An investigation into implementation of Curriculum 2005 in Senior phase of a Junior Secondary School in the Lusikisiki district. Published master's degree of education. University of KwaZulu-Natal, Durban.

Mercer, N., & Sams, C. (2006). Teaching children how to use language to solve maths problems. *Language and Education*, *20* (6), 507-528.

Merriam, S.B. (1998) Qualitative research and case study applications in education. Jossey-Bass Education series.

National Policy Pertaining to the Programme and Promotion Requirements of the National Curriculum Statement. (2015).

National Report on The State of Literacy Teaching and Learning in the Foundation Phase. NEEDU.

Ngidi, D.P., & Sibaya, P.T. (2003). Student teacher anxieties related to practice teaching. *South African Journal of Education*, 23 (1), 18-22.

Ntsoane, R. (2018). *How student teachers engage with the making of teaching tools for mathematics pedagogy*. Unpublished master's dissertation. Johannesburg: University of South Africa.

Patton, M.J. (1991). Qualitative research on college students: Philosophical and methodological comparisons with the quantitative approach. *Journal of college student development*.

Petersen, N.P. (2017). The liminality of new foundation phase teachers: Transitioning from university into the teaching profession. South African Journal of Education, 37 (2), 1-9.

Pretorius, E.J. (2002). Reading ability and academic performance in South Africa: Are we fiddling while Rome is burning? Language Matters, 33, 169-196

Reddy, C., Menkveld, H., & Bitzer, E. (2008). The practicum in pre-service teacher education: a survey of institutional practices. Southern African Review of Education, 14 (1), 143–163.

Reed, Y., & Taylor, N. (2014). The Initial Teacher Education Research Project Report on English courses for Intermediate Phase student teachers at five universities. JET Education Services.

Richter, D., Kunter, M., Lüdtke, O., Klusmann, U., Anders, Y., & Baumert, J. (2013). How different mentoring approaches affect beginning teachers' development in the first years of practice. Teaching and Teacher Education, 36, 166-177.

Rusznyak, L. (2014). Preparing teachers for effective classroom practices. Teachers Upfront Seminar. University of the Witwatersrand, South Africa.

Schoenfeld, A.H. (1985). Mathematical Problem Solving. New York: Academic Press.

Schoenfeld, A.H., & Floden, R.E. (2014). An introduction to the TRU Math Dimensions. Berkeley, CA: Graduate School of Education, University of California, Berkeley & East Lansing, MI: College of Education, Michigan State University.

Schoenfeld, A.H., & the Teaching for Robust Understanding Project. (2016). *An Introduction to the Teaching for Robust Understanding (TRU) Framework.* Berkeley, CA: Graduate School of Education. Retrieved from http://map.mathshell.org/trumath.php or http://tru.berkeley.edu.

Schon, D.A. (1983). The reflective practioner. San Fransisco, CA: Jossey-Bass.

Sedumedi, T. D. (2014). The Use of Productive Inquiry in the Teaching of Problem Solving in Chemical Stoichiometry. *Mediterranean Journal of Social Sciences*, *5*(20), 1346.

Shandomo, H.M. (2010). The Role of Critical Reflection in Teacher Education. School–University Partnerships, 4 (1), 101-113.

Shenton, A.K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. Education for Information, (22), 63–75.

Shulman, L. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher,* 15 (2), 4–14.

Shulman, L.S. (1987). Knowledge and teaching: Foundations of the new reform. Harvard Educational Review, (57), 1-22.

Simon, M.K. (2011). Validity and Reliability in Qualitative Studies. Dissertation and Scholarly research: Recipes for success. Seattle, W.A, LLC.

Sinclair, C. (1997). Redefining the role of the university lecturer in school-based teacher education. Asia-Pacific Journal of Teacher Education, 25 (3), 309-324.

Spanenberg, E. (2014). Mathematics Student Teachers' Experiences of Mentoring At a Teaching School in South Africa. University of South Africa.

Spaull, N., & Kotze, J. (2015). Starting behind and staying behind in South Africa. The case of insurmountable learning deficits in mathematics', *International Journal of Educational Development,* 41, 13–24.

Stoddart, T. (1990). Introduction to the volume. In T.Stoddart (Ed.), Perspectives on guided practice (Technical Series 90-1; pp. 3-6). East Lansing, MI: National Center for Research on Teacher Education, Michigan State University.

Swain, J. (2017). Designing and managing your research in education in the early stages. Designing Research in Education. Concepts and Methodologies. Sage Publishers.

Taylor, N. (2007). Equity, efficiency and the development of South African Schools. International handbook of school effectiveness and improvement, 523 – 540. Springer, Dordrecht.

Townsend, P. (2010). The meaning of poverty. *The British Journal of Sociology*, 61 (1), 85 – 102.

Turner, J., Styers, K.R., & Daggs, D. (1997). Encouraging mathematical thinking. *Mathematics Teaching in the Middle School,* 3(1), 1997, 66-72.

Valencia, S. W., Martin, S. D., Place, N. A., & Grossman, P. (2009). Complex interactions in student teaching: Lost opportunities for learning. *Journal of Teacher Education, 60 (*3), 304-322.

Van Reyden, D. (2008). The Rights to respect for Autonomy. *South African Journal of Occupational Therapy*, 38 (1), 27 – 31.

Vick, M. (2006). It's a difficult matter: Historical perspectives on the enduring problem of the practicum in teacher preparation. *Asia-Pacific Journal of Teacher Education*, 9 (34), 181–198.

Vygotsky, L.V. (1978). Mind in society: The development of higher psychological processes. Cambridge, MA: Harvard University Press.

Wang, J., Odell, S., & Schwill, S.A. (2008). Effects of teacher induction on beginning teachers' teaching. *Journal of Teacher Education, 59* (2), 132-152.

Wolcott, H.F. (2001). Writing up qualitative research. 2nd edition. London: Sage.

Wood, T., Cobb, P., & Yackel, E. (1991). Change in teaching mathematics: A case study. *American Educational Research Journal*, *28* (3), 587-616.

Youngs, P., & Qian, H. (2013). The influence of university courses and field experiences on Chinese elementary candidates' mathematical knowledge for teaching. *Journal of Teacher Education,* 64 (3), 244–261.

Zeichner, K. (1999). The new scholarship in teacher education. *Educational Researcher, 28* (9), 4-15.

ADDENDUM 1: Ethics Clearance Certificate

NHREC Registration Number REC-110613-036

UNIVERSITY
OF
JOHANNESBURG

ETHICS CLEARANCE

Dear MS MN Khasu

Ethical Clearance Number: 2018-024

Mentoring for mathematics teaching in the foundation phase: The views of students and their mentors

Ethical clearance for this study is granted subject to the following conditions:

- If there are major revisions to the research proposal based on recommendations from the Faculty Higher Degrees Committee, a new application for ethical clearance must be submitted.
- If the research question changes significantly so as to alter the nature of the study, it remains the duty of the student to submit a new application.
- It remains the student's responsibility to ensure that all ethical forms and documents related to the research are kept in a safe and secure facility and are available on demand.
- Please quote the reference number above in all future communications and documents.

The Faculty of Education Research Ethics Committee has decided to

☒ Grant ethical clearance for the proposed research.
☐ Provisionally grant ethical clearance for the proposed research
☐ Recommend revision and resubmission of the ethical clearance documents

Sincerely

Dr David Robinson
Chair: FACULTY OF EDUCATION RESEARCH ETHICS COMMITTEE
7 February 2019

ADDENDUM 2: Interview transcripts

Focus Group 1

Line 1. **N:** So the first question I would like to ask you is what do you consider important for mathematics teaching?
Line 2. **S1:** I think as a teacher you should know what maths is and what it is
Line 3. about before you can teach children. You must know what you're going
Line 4. to teach and how you're going to teach because you can know maths,
Line 5. but if you can't teach it then it's like what are you saying to the children.
Line 6. **N:** Any other responses?
Line 7. **S2**: As a teacher you need to identify how different learners learn
Line 8. mathematics. So one learner can just listen to the teacher explain, but
Line 9. when it comes to the learners, they might need practical examples.
Line 10. So the teacher needs to be able to identify how
Line 11. learners learn and understand maths.
Line 12. **S3**: I think it is also important that the teacher knows the learner's prior
Line 13. knowledge. Because if we as teachers don't know their prior knowledge,
Line 14. then how will we know what we supposed to build up on.
Line 15. **N**: Ok. What else do you think for teaching personally you need to know for teaching maths?
Line 16. **S4**: To add on what she just said, content knowledge is very important.
Line 17. Without it, there is no way forward.
Line 18. **N:** Could you elaborate more by what you mean by content knowledge?
Line 19. **S4**: Content knowledge is the knowledge of maths and understanding
Line 20. what you need to teach to your learners. You can't really teach learners
Line 21. what you don't know or understand.
Line 22. **N**: Thank you. What other methods do you generally use to teach maths?
Line 23. And what content goes with these methods? So give me an example of
Line 24. the content area you would teach and description of the method you
Line 25. would use to teach that particular concept.
Line 26. **S2**: So for example in mathematics we learn about the stages.
Line 27. Of how to teach maths. So your concrete stage, semi-concrete abstract
Line 28. stage. So when you are introducing a new topic for example
Line 29. multiplication. You'll obviously do concrete and practical work.
Line 30. Using your counters or ice-cream sticks.
Line 31. Physical things for them to count and group.
Line 32. Then from there you slowly take that way.
Line 33. Then it becomes more abstract.
Line 34. They can do it on their own and then you get them to write in their books.
Line 35. To show their understanding of what they have learnt.
Line 36. **N**: Any other methods you've learnt that you use to teach maths, any other methods you use?
Line 37. **N**: Ok can you give me an example of a concept you've taught before
Line 38. and how you taught that concept or that you've observed.
Line 39. **S5**: What I have observed from WIL is that the teacher was teaching.
Line 40. Before she would teach, she would make them count, like if maybe they
Line 41. were doing numbers from 100-200, then they would count. She had this
Line 42. method of having them clap while counting. It was so nice and the way
Line 43. she introduced the numbers in three-digit form, the hundreds, tens and
Line 44. units. She would have the base ten blocks and I found that to be very
Line 45. good because can see what you're talking about. Rather than saying 700 is 700 and getting frustrated. At least learners can see so many blocks and so on. At least they get me and so on.

Line 46. Sometimes I think I learn more at WIL than at the teaching school.
Line 47. **N:** So you think resources are important to assist your teaching method?
Line 48. **S5**: Yes, I do.
Line 49. **N:** Any other method that you have used in the classroom?
Line 50. **S1**: I think the discussions between the teacher and the learners is also
Line 51. very important because when the teacher teaches for a very long time
Line 52. without the learners participating. Then it becomes very difficult for the
Line 53. teacher to know whether the learners are learning or not.
Line 54. Questioning and answering is also very important for the learners.
Line 55. **S2**: I would like to add on that. Like what I have observed at WIL.
Line 56. It was a small class, the teacher divided the learners into two groups.
Line 57. She had the group with stronger learners and a group with not
Line 58. necessarily weaker learner, but learners who take longer to grasp the
Line 59. concept. That worked out because when she teaches the slower group,
Line 60. there are no learners rushing or getting bored because she is explaining
Line 61. the concept a few times or using different methods to help them.
Line 62. So I feel like there was reflection in action, like she separated them in
Line 63. groups and teaching them separately.
Line 64. **N**: Thank you, any other responses to that?
Line 65. **S5**: Just to add on, where I was, she would take the learner's,
Line 66. like they know this concept. Then she would take those learners to teach
Line 67. the others. Like peer teaching and learners would grasp and I think peer
Line 68. teaching is also very important, maybe a learner can teach it better than
Line 69. you or explain it better.
Line 70. **N**: Ok thank you for that. Ummmh. So does the mentor teacher guide
Line 71. you in the kinds of methods that you would use? Do you find that a lot of your methods are often informed by what you observed from the mentor teacher?
Line 72. How does the mentor teacher guide you after the mentoring sessions?
Line 73. **S1**: I feel like in most cases, a mentor teacher will stay in their comfort
Line 74. zone and is the direction that they will steer you in. So if they like a certain
Line 75. something, they will advise you do that and shy away from using different
Line 76. methods or using different resources and what not. So sometimes it does
Line 77. become difficult to expand our lessons because its' just like we feel
Line 78. restricted in a sense and not able to tell this to the teacher.
Line 79. **N:** So is this referring to the mentor teachers here at the teaching school?
Line 80. Specifically, I am asking about the mentor teachers here at the teaching school?
Line 81. **S1**: Yes, it's here at the teaching school.
Line 82. **S3:** It does happen.
Line 83. **N**: Does everyone else share the same sentiments?
Line 84. **S1**: Yes, I would think so. It does happen
Line 85. **N:** Any other responses to how the mentor teachers guide you?
Line 86. **S4**: Like she said, I feel that they're (the mentor teachers)
Line 87. are not allowing us to do things in a way that we would like to do them.
Line 88. We are mostly limited to doing things in the method they would want us
Line 89. to use. Like what we do is always going to be criticized as to say that our
Line 90. methods are always going to be criticized, that our learners are used to
Line 91. so and so. We can never get the opportunity to say that Mam, since you
Line 92. did it this way how about we take a different direction or a different
Line 93. approach, to see if learners will understand it better or not.
Line 94. And the learners now that we have seen that the mentor teacher expects
Line 95. us to do this and they're used to seeing the mentor teacher do that. It is
Line 96. almost as if we are expected to exactly do what we see.
Line 97. **N:** Ok, any other responses to that? So do you find the mentoring sessions helpful before you plan the lesson?
Line 98. **S3**: Yes, I find them very helpful because you now know what is
Line 99. Expected of you. Rather than going there and wondering where you are

Line 100. going to start. They give us direction. Every time you go to a mentoring
Line 101. session, you grasp something new that you didn't know. Also being
Line 102. exposed to different mentors helps because you'll know exactly what to do.
Line 103. **S6**: Also it helps you, like you know what levels the learners are at.
Line 104. For instance, when you go to the grade 2 class and you see that the
Line 105. teacher is explaining things this way but in grade 1 the teacher explained
Line 106. it differently. But now she is using higher words or difficult words with
Line 107. them. So that they understand it better and that they learn
Line 108. new terminology as well.
Line 109. **N**: So are you saying that there is sort of like a progression?
Line 110. **S6**: Yes, there is.
Line 111. **N**: Is this progression between the mentor teachers and is your experience the same in every mentor teacher's class?
Line 112. **S6**: No I don't experience the same. So grade 1 regarding
Line 113. mentoring wasn't the same as grade 2. The grade 2 teacher
Line 114. uses higher language than the grade 1 teacher.
Line 115. **N**: Oh ok, so do you guys feel that your experiences from the grade R, grade 1 and grade 2 classes regarding mentoring?
Line 116. **N:** Have those progressed? Or do you feel that you are not learning much from the mentoring sessions in grade 1 as compared to grade 2?
Line 117. **S4**: I feel like they're almost the same. Other times the teachers will be
Line 118. like you guys need to improve here and here. The next time they will be
Line 119. like no, after that you guys should change. Then you ask yourself,
Line 120. where are we now?
Line 121. **S2**: The mentoring sessions were all helpful as in guiding us on
Line 122. what to do with the lesson. Giving us the topic, giving us pointers.
Line 123. But when it comes to actually producing the actual lesson.
Line 124. Sometimes the advice given to us by the mentor teacher will contradict what we are learning at the university. Then we are left confused.
Line 125. Mmmmh (Students all sigh in agreement).
Line 126. **N**: (laughs). You guys all feel a strong sense that sometimes what you're told by the mentor teacher contradicts what you're learning. Is this now from the university?
Line 127. **S4**: Yes.
Line 128. **S2**: Yes, from the university.
Line 129. **S3**: Yes
Line 130. **N:** So do you think that there isn't a clear link from what you learn from the university versus what you are expected to do in practice?
Line 131. **S2**: Yes, and which I actually don't understand because it's one.
Line 132. So you would expect what we are learning to be similar to what the
Line 133. mentor teachers want. It confuses us as groups and that's how we lose
Line 134. marks. Because we will do a lesson a certain way and then
Line 135. when our lesson plan is reflected on, then we have to change things.
Line 136. So then it makes it difficult for us because what are we changing it
Line 137. to next because we just know what we have been learning,
Line 138. what we have been taught at the university.
Line 139. **N**: Ok alright, I just want a little more feedback on that. Is it that there are differences between the mentoring sessions and the post lesson evaluations? So after you've presented the lesson,
Line 140. **N**: Do the mentors contradict themselves from what they said in the planning session versus the feedback they give you after you've presented?
Line 141. **S3**: I feel like the lesson, when they were giving us feedback, they told
Line 142. us certain things to do and when we put it in our lesson plan.
Line 143. Then we thought the lesson would be great. Then when the feedback comes back.

Line 144. The mentor would say you must change this, it won't work. But the mentor said it will work, you understand.
Line 145. **S6**: Like when we were doing our lesson on sharing and the dividing (division).
Line 146. They said we must bring in the word division but then when we put it in
Line 147. our lesson plan, the mentor teacher said we mustn't use the word
Line 148. division. They said we can also teach the remainder.
Line 149. Then when we put it in our lesson plan, they told us we're not allowed to do that.
Line 150. So were confused.
Line 151. **S1**: Sometimes there are confusions.
Line 152. **N**: So anything else regarding mentoring about teaching maths that you
Line 153. would like to share? What would you like to see happening as a way forward?
Line 154. **S4:** Personally, I think that when they are mentoring us they should be clear.
Line 155. They should be clear and they shouldn't move from saying this and then
Line 156. doing something different the next time when you get there.
Line 157. I also feel that, in terms of maths when in the classroom.
Line 158. I know we said that content was very important. Yesterday there was a
Line 159. bit of the misunderstanding regarding how the teacher explained to learners.
Line 160. When we asked about it because we were not certain as to how it was being done.
Line 161. After that, I went home and researched that whole topic the mentor
Line 162. teacher was teaching learners. Most of the answers I got, were opposite
Line 163. of what the mentor teacher was teaching. So I feel that before they actually teach a lesson.
Line 164. She was supposed to teach after them.
Line 165. They should actually find the proper information and do research on it as well.
Line 166. As much as they would also like us to do research on those maths topic and maths teaching.
Line 167. I feel that they should also do research.
Line 168. Instead of just saying no. This is how you're supposed to do it.
Line 169. At the end of the day, as much as we are students it doesn't necessarily mean we're completely clueless as to what should be taught in the maths class.
Line 170. **S3:** I find that they emphasize on how we should include the learner's in our lessons but I find that most times they don't.
Line 171. It's like they just tell the learners what to do and then the learners must just do it.
Line 172. The learners are just exposed but they don't have excitement to do maths.
Line 173. They don't include the learners, not always but it happens.
Line 174. **N:** So do you feel that what is expected from you is not being modelled to you?
Line 175. Is that something that you guys are experiencing all the time or at times?
Line 176. **All students:** At times.
Line 177. **S4:** Yeah it's mostly at times.
Line 178. **N:** So at times you find that what is expected is not always being modelled?
Line 179. **S1,3, 5 & 2:** Yes (Nodding their heads in agreement).
Line 180. **N**: Is there anything else that you would like to share regards maths
Line 181. teaching or mentoring that you would like to share? Any other comments?
Line 182. **S3**: During the mentoring sessions the mentors speak in one voice but when we get to the class, then she will say change this.
Line 183. I feel like why didn't the mentor teacher do that when we were in the mentoring session, so that everyone can hear that and participate.
Line 184. Maybe the other one didn't know why he said to us we can share the remainder.
Line 185. Then the one mentor teacher says they are too young.
Line 186. The one said we must expose the learners. Like contradiction.
Line 187. **S2**: And it's also difficult because we have had two cycles only. We've only had two mentoring sessions with the two teachers. So it's not enough time really.
Line 188. With the first mentoring cycle it was the first teacher (the lady) that was explaining to us and now it is the male. So you can't really say.
Line 189. I don't really know what happens in the other classroom.

Line 190. He is in one voice, where what he says in the mentoring is the same as what he expects from you.
Line 191. **N**: Is there any other comment students?
Line 192. **N:** Nothing, alright. Thank you very much students.

Focus Group 2

Line 193. **N:** What do you guys consider important for maths teaching? So what do you think is important before you can teach maths? What must you know?
Line 194. **S6:** So the first thing you need to know is what do the students know first about maths.
Line 195. Then we can take it from there about what we're going to teach them. So like just basic maths, do they know how to count? Things such as sharing yeah.
Line 196. **N:** Yes student
Line 197. **S7:** I think uhm for maths teaching you must have proper understanding of the maths. You must be able to, like make sure you can accommodate each and every learner in the class.
Line 198. **N:** Any other responses to that? What else is important?
Line 199. **S8:** I feel like what is important firstly, is understanding yourself as a maths teacher. Because you know what are your strongest points and your weakest point.
Line 200. You can't teach maths, if also you yourself you do not understand the basics of maths.
Line 201. Because, I'm not good in maths, but I'm able to learn and try and figure out what I need to know for me to be able to share what I know.
Line 202. **N:** Thank you. So what are some of the methods that you use to teach maths? Maybe you can give me an example of this is how I could teach a certain topic in maths and I could approach it with a certain method.
Line 203. **S8**: Can I say this?
Line 204. **Ntsiki: Yes.**
Line 205. **S8:** I feel like teaching time is my strongest point in maths because I am good with graphic, visuals, drawings and paintings.
Line 206. So when I would teach time, I would make a beautiful big watch with all the time intervals in it.
Line 207. It can even be electronic and make it move. So I feel like it's important for you to understand yourself.
Line 208. Teaching is my strength. Because sometimes cannot see what you're talking about, they need to see to be able to manipulate what you're talking about.
Line 209. **N:** So you are raising a point of demonstrating methods and also incorporating a bit of technology in the classroom.
Line 210. **S9:** Being creative.
Line 211. **N:** Being creative, so how would you show what method would you say is a creative method?
Line 212. **S9:** Like what he said like using what you are best at. Incorporating it with the method.
Line 213. **S10:** Can you repeat the question?
Line 214. **N:** Ok so it's basically, what are the methods you use to teach mathematics concepts?
Line 215. **S10:** I think the other one is explanation because then if you're explaining and you're teaching the learners about money.
Line 216. For them to understand that a R10 can be two R5 and five R2 can make a R10. You should explain that to them and also just explaining to learners, doesn't mean they will understand.
Line 217. They need to physically see the R2 and R5. It will make them understand better, even if you give them a worksheet afterwards.
Line 218. **N:** So based on what you said, do you think that it is important for learners to also discuss what they understand?

Line 219. **S10:** Yes, you will never know If the person knows what you're talking about, unless they ask you questions and they say back. Or when you ask them question, they say back what you were asking.

Line 220. **N:** Ok. Any other responses to methods you have seen specifically here at Funda, are there any methods you have seen, that really strike you as innovative?

Line 221. **S11:** We were doing something that really engages learners. For example, when we were teaching place value and rounding off. I even came up with a story.

Line 222. Maybe say there are ten houses. The first house is zero, one, two, three and up to the tenth house.

Line 223. Maybe just now you're standing at number four and it's raining, which of the nearest house will you go to? The ten or zero? Then they will know that from five downward, you must go back to the zero.

Line 224. **S8:** I'm not sure if I will be using the correct words but you can use the learners as your apparatus.

Line 225. For instance, if you're teaching length, then you can take the short learner and the tall learner and just tell a story a bit about the other one. Ok so this one is taller than the other one and this one is shorter than the other one.

Line 226. N: Ok

Line 227. **S10:** The other thing I have seen is that here, we usually do discussions among the learners and put them in groups.

Line 228. Then you can choose one learner and have an answer from each learner, then it's much quicker if you do things in groups.

Line 229. It's also easy for them to come up or have answers. You can even ask them questions individually when they are in groups.

Line 230. **N:** So I would consider group work also as another method you can use. So the given what you told me. How does the mentor teacher guide you for teaching mathematics? Specifically, here at Funda. So in the mentoring sessions, how do the mentor teachers guide you?

Line 231. **S7:** Before we do our actual lesson, we first observe the teacher doing the lesson we going to do.

Line 232. So that we can know this is what we're going to do and what she has already done. So we have to add on it.

Line 233. **S10:** And another thing, I think most of the time we don't use the right words or phrases for mathematics teaching.

Line 234. So most of the time, the teacher will tell us the exact words or hint the words we're supposed to use.

Line 235. Most of the time hint one over five and we'll probably not use the name denominator and numerator and not use the right terminology of saying it.

Line 236. So the teacher will always emphasize to use the right terminology.

Line 237. **N:** Do you feel that the mentor teachers allow you to use more creative method? Do they guide you to use more creative methods? Or is it mostly to the same methods they are using.

Line 238. **S8:** I feel like even before the teaching of the actual lesson, there is a procedure of submitting the lesson plan, so that the teacher can see the lesson plan and give us feedback of what she thinks.

Line 239. So now what happens is she adds on the lesson plan and gives us some ideas on how to improve the lesson.

Line 240. So I feel like she has more to do with the creativity of the lesson. She does guide us in the creativity and methods of actually teaching the mathematics.

Line 241. **N:** Ok. Any other responses to that?

Line 242. **S7:** And uhmm the mentor teachers they want us like to, to give, explore. Like thina size nento zethu (They want us to bring our own things).

Line 243. Wena i-method yakho uzoyiyenza kanje (How you are going to implement your method). Hai ukuthi uyenze the way yena ebesenza ngakhona (Not to do it in the exact manner the teacher used).

Line 244. So ufuna ukuthi wena ubona ukuthi (She wants you to see) this is how I'm going to attack this lesson. These are the methods engizoza nazo (I will come with) for me to engage the learners in the lesson.

Line 245. **S9**: So they do give us space to be a little bit more creative and come up with new things, maybe what she never thought of.

Line 246. **N:** Ok, thank you. So then I'll ask you how the mentor teacher helps in the mentoring sessions after you've taught the lesson. So how does the mentor teacher help you after the lesson?

Line 247. **S8:** I feel like the teacher gives us room for improvisation because we are able to share how we felt about the lesson.

Line 248. She creates a space where we can be confident to say I like this or I did not like this. But not that, the next time I suggest we can do this.

Line 249. But not only that, so you need to be able to say for the next time, I suggest we can do this because there are some people who do not participate in the actual planning of the lesson.

Line 250. Now when we are reflecting, we get a chance to say ok guys this is what went well. Even though there too many of us in the group.

Line 251. Some group members are dominating in the planning and some do get a chance during the planning.

Line 252. The mentor will try to include everyone in the reflection session.

Line 253. **N:** So do you guys find that after the lesson, does the mentor teacher help you in terms of your PCK, meaning your teaching method. Or is it mostly related to classroom management. What goes on? Is it mostly related to how you taught or is the focus more on what happened in the classroom?

Line 254. **S12:** Ummh, she does correct us on how we teach, like your PCK method.

Line 255. Teaching skills, she also puts more emphasis on conceptual understanding of mathematics. Like the use of language for mathematics. So she does emphasis on that.

Line 256. **N:** Is this regarding the PCK?

Line 257. **S12:** Yes.

Line 258. **S9:** Most of the time the teacher won't really focus on the behaviour of the learners.

Line 259. It's your responsibility as a teacher, to know how to control the learners.

Line 260. So she'll focus most of the time on the way you were teaching and what you need to improve on.

Line 261. **N:** Alright. Then do you find that your mentoring experiences from your first, second and third year develop? Or are they more likely the same?

Line 262. **S8:** Like they have developed. In grade 1 we were doing English, now were doing maths with grade 2 learners. So were learning things we did not know about teaching maths.

Line 263. Like today, I also learned when you write a number on the board, you do not write a full stop, which I always did. After writing a number, I always did.

Line 264. She said, if you write a full stop, then you're indicating this is a question. So I feel like it has improved.

Line 265. **S7:** So it has improved. Even though you see that the teacher's here have a connection because even the way they teach is not the same.

Line 266. They have the same kind of vision or the same kind of way of doing things. It has improved the way I see it.

Line 267. **N:** Then in terms of maths teaching and mentoring, like how you have been mentored, is there anything else you would to share regarding mentoring here at the teaching school or how maths is taught here at the teaching school?

Line 268. **S10:** I think the mentoring here at the teaching school has helped a lot because when we go to the outside schools, we're not scared.

Line 269. We’re confident when we’re standing in front of the learners because we’re used to it here at teaching school.
Line 270. **S8:** It has helped because when I went to my WIL. I had a lesson on place value of which I used a method, which I observed here at the teaching school, to teach the grade 2’s.
Line 271. I was quite happy with the response because I was declared the maths boss (laughs).
Line 272. **N:** Mmmh
Line 273. **S9:** Yeah because last year I was doing my practical’s in my second year. Even the principal asked us to leave the lesson plans behind because they were good.
Line 274. We learnt a lot from the teachers. It gave us confidence. Here at Funda we see things that are not done anywhere else.
Line 275. So you think if lana (here) they are doing so much and I have learned so much.
Line 276. I came to a school lapho (where) they know just little bit of things.
Line 277. You become extremely confident and everything you do you do it at the best of your abilities.
Line 278. **N**: Alright, thank you very much students. Anything else you would like to share?
Line 279. Silence.
Line 280. **N:** Thank you very much students.

Individual interview 1 (Pilot)

Line 281. **N:** What do you think student teachers need to know in order to teach mathematics effectively?
Line 282. **MT1:** First of all, they need to have the basic knowledge of how to teach maths in the foundation phase. They need to know maths.
Line 283. They need to have learned something about maths.
Line 284. They also need to know what’s trending, the new methods and new ways of teaching maths.
Line 285. They need ways of teaching now, inconsideration of 21st century learner. So I think those are the fundamental things they need to know.
Line 286. **N:** having observed student teachers teach in the grade 1class. Can you give us your impression of the approaches they use firstly? Are there any specific methods you encourage them to use?
Line 287. **MT 1**: Mmmh Above all else I think one thing that we encourage is that every learner should be involved.
Line 288. Every learner should participate. Every learner should be part of the lesson. As opposed to the teacher always talking and talking over the children.
Line 289. Maths is more about application. It’s more about practice. It’s about applying what you know. It’s more about even sharing different methods of doing things.
Line 290. So as student teachers teach, we encourage them to do that, we encourage them to use teaching aids because certain concepts are so abstract for a grade 1 learner.
Line 291. You cannot just come and talk about for crying out loud talk about doubling and halving yet you’ve not taught them about sharing or sharing equally.
Line 292. So what we tell them in their method is that they have to always have teaching aids for the learners,
Line 293. So that they apply their knowledge and they are able to show you their workings on how they got their answer.
Line 294. You are able to refute even to edify on what they have given you, then you need to do so.
Line 295. And also exposing other learners to different methods. So it’s basically using different ways and also multimedia. You can use videos, you can use pictures and you can use just even stones from outside.
Line 296. Any material just for the concept to be dealt well with.

Line 297. **N:** What is the nature of the reflection after the lesson presentations? How do you guide students in reflecting after the lessons?

Line 298. **MT1:** Well we do have a rubric that we use, but before I use that rubric I give them the opportunity to talk about the lesson and what they observed and what they liked and disliked.

Line 299. But I don't dwell much on what went wrong. I encourage them to give me at least three things that they have done well and they felt confident about.

Line 300. And one thing they can learn from, not specifically saying one thing that was wrong, but something the can use as a learning curve.

Line 301. Umm in guiding them, we talk about the planning session, how did they plan their lessons, we talk about the lesson itself.

Line 302. We talk about group involvement, we talk about the body of the lesson and whether the concept was understood by the learners.

Line 303. We talk about classroom management; we talk about what they themselves as teachers in understanding what they would do.

Line 304. Whether something did not work out, what is the best way of changing it for the next lesson even if it's not for mathematics but any other lesson?

Line 305. So you give them an opportunity to reflect.

Line 306. The one key point is not allowing them to dwell on the wrongs so much because they end up feeling very distraught and discouraged.

Line 307. So when you give them something, even from their peers. That is when I ask them to give critical but encouraging feedback.

Line 308. As opposed to saying you're wrong here, you're right here type of thing.

Line 309. **N**: Do you find that when they reflect, are they dwelling on their teaching method or do they focus on other contextual factors that affected their lesson?

Line 310. **MT1**: I think for me, we sought of do a holistic reflection session. We talk about the methods that they used and how they benefited their teaching.

Line 311. They we go back to their lesson plan and look at what they said they were going to do and if they didn't do it, we ask why they didn't do it.

Line 312. Because sometimes a lesson may not go the way you want. We want them to get to a point where they critically think about their methods and why they altered them as they teach.

Line 313. So that's where we are. So when I say it's holistic, it's about them, the learners, the classroom management, the teaching of the concept and the methods that they use.

Line 314. **N:** Thank you. Is there anything else you would like to share regarding maths teaching and mentoring? Maybe your experiences of mentoring students.

Line 315. **MT1**: I somehow feel that students need to be given opportunities to apply their knowledge after they have learnt something.

Line 316. So if you are teaching them or lectured on measurement, they need to create a lesson with teaching aids based on measurement or whatever concept within measurement.

Line 317. They need to pick a particular grade and if let's say the third years are being lectured on that.

Line 318. They need to come back to the here and be given an opportunity, even if it means teaching a group three learners and allowing them to do those activities.

Line 319. At least they have gotten some practice and the now understand how to do it, giving them an idea of what the can do best at a larger scale.

Line 320. So I think, we want them to reach a point of balance between theory and application.

Line 321. So we need to give them such opportunities and not allow them to do it only when one of them is teaching only on a Thursday.

Line 322. But I think it needs to be done and planned with the school and the teachers, that on a particular day after you have consolidated everything as a lecturer.

Line 323. Then during a particular week, students come through and come in to teach that particular concept.

Line 324. They can rotate. They can come in on Monday or Tuesday, or any other day. As long as all the third year in that week get an opportunity to teach. Currently there are too many of them in the group.

Line 325. Or it could be done over weeks, so that they are able to know how to implement and to be able to reflect on the knowledge that they get.

Line 326. **N:** Fine, thank you. Is there anything else that you would like to share?

Line 327. **MT1**: No

Line 328. **N:** Thank you.

Individual interview 2

Line 329. **N:** Fine. Thank you. The first question I want to ask is that, what do you think student teachers need to know, in order to teach mathematics effectively?

Line 330. **MT2**: Ok I think they need to know what content needs to be covered in grade 2.

Line 331. If they are in the grade 2 class and then they also need to know the best approaches or the best methods to use to teach the learners effectively.

Line 332. Also they must know the basic or prior estimated prior knowledge of the learners.

Line 333. So that they know what needs to be covered, so that they can base their lesson plan on what they have done and what they need to do at the present moment.

Line 334. **N:** Thank you. Having observed student teachers teaching in the grade 2 class. Can you give us your impression of the approaches they use?

Line 335. **N:** Meaning that are there any specific methods, that you encourage student teachers to use and can you tell me what methods do you always see them using?

Line 336. **MT2**: Mmmh , I go for and I see it being effective when they use interactive methods.

Line 337. Because with that method, they are able to involve the maximum number of learners during their teaching.

Line 338. Learners get involved, learners get to understand better as they go through the lesson yah.

Line 339. **N**: Are these the same methods that you always see them use, do they change methods or do most groups use similar methods all the time?

Line 340. **MT2**: No they do change methods. I encourage them to use different methods.

Line 341. However, I always encourage them to use a particular method for a particular topic because not all of them are relevant for each topic.

Line 342. For example even group work is also important but not all the time. So they can use a variety of methods.

Line 343. **N**: Ok thank you. Then what is the nature of the reflection after the lesson presentation? Meaning that how do you guide them in reflection after presenting lessons?

Line 344. **MT2:** Ok first of all, I want to hear from them how they think they delivered the lesson.

Line 345. Then I want them to talk about and I want to see if they are able to pick up on their flaws if there are any or maybe the best methods.

Line 346. Or if the methods they used were effective enough to achieve their objectives.

Line 347. **N:** Ok. Do you find that they reflect on their teaching methods or they reflect on other things that affected their lesson? What do they mostly dwell on a lot?

Line 348. **MT2**: Ok, they do both. Most of the time they focus on what caused the lesson not to go well.

Line 349. So instead of focusing on the method they using as to why was it not effective and what made it effective if it was effective. They need to reflect on their teaching methods.

Line 350. Or they just focus on the fact the learners did this or the learners did that and so on.

Line 351. **N:** Is there anything else you would like to share regarding maths teaching and mentoring? Anything on mentoring you would like to share, is it helpful?

Line 352. **MT2**: Ya luckily, If maybe I would like them to try and use all the methods.
Line 353. Again they must be able to see which method is effective for a particular topic at that time.
Line 354. So bangathi (they must not) force the discussion method when it's not going to work nama (also) group work when it is not going to be effective.
Line 355. So ya and also they must ensure they know how much content they need to cover for grade 2 learners.
Line 356. Bangathi (they must not) say if they are teaching 3D shapes, then they just 3D shapes according to just their understanding and knowledge.
Line 357. Having not looked at the level they must children up to.
Line 358. **N:** Thank you so much Mam.

Individual interview 3

Line 359. **N:** So what do you think student teachers need to know in order to teach maths?
Line 360. **MT3**: I think you need to know more of the content and we all know when it comes to the pedagogy that will be developed as they practice more.
Line 361. So it's more about the content knowledge, your mathematical cognition part of it.
Line 362. In the foundation phase it will be more based on your number sense specifically.
Line 363. Students are really struggling with that and they actually throw that to learners. You know those big numbers or even if it can be small numbers a three or two.
Line 364. So they throw a lot of that unto children without a clear understanding of the language itself. You know a lot of operational signs, they also throw them without explaining the actual meaning of those symbols.
Line 365. They are just symbols and they are very abstract for learners in grade 1, 2 and some in grade 3. Especially in grade 3 it will be more about the division sign.
Line 366. So if you just throw the division sign without actually explaining or giving meaning it or using language rather then it becomes very confusing for the learners.
Line 367. I would say its number sense and mathematical language is what they are basically lacking.
Line 368. **N:** Ok. So having observed student teachers teach in the grade 3 classes. Can you give us an impression of approaches or methods that they use?
Line 369. **MT3**: Ummmh. You know in most cases the approaches that they use, they are just moving from ummmh the lesson plan to whatever that they say to the learners.
Line 370. They don't have a specific method that they use. You will find them just teaching because that is what they were told to do.
Line 371. They must just teach and ummh the strategies they use are your question and answer in most cases and it will be more explaining than them teaching basically.
Line 372. You know when they reach the fourth year level they try to come up with some sort of activities like a play, games mostly.
Line 373. But you find that mostly in those games they are missing the teaching part of it. It's just playing games.
Line 374. They miss the teaching part of the concept or concept basically.
Line 375. So it's mostly question and answer and more of just talking you know about whatever that they were teaching than teaching the learners or doing it for learning purposes basically.
Line 376. **N:** So with what you said now. So do you think they develop conceptual understanding or just procedures? How to do certain procedures?
Line 377. **MT3:** I would think they are more on the facts as well as the procedures.
Line 378. When it come to the conceptual knowledge in their teaching methods,
Line 379. they are lacking and I don't see them achieving that without being mentored or shown to say this is what you actually need to say or teach.
Line 380. So it's more of the procedural knowledge and facts basically.

Line 381. **N:** So are there any specific methods you encourage them to use. Anything you suggest for them to use.
Line 382. **MT3:** Like I said ummmh, it's more of looking into the conceptual knowledge when teaching mathematics.
Line 383. If they plan, yes the facts and the procedures will always be there.
Line 384. But it's more of assisting learners in understanding those numbers and understanding mathematics.
Line 385. We all know that mathematics is just a language that we use in our everyday life.
Line 386. So I normally say to them they need to critically look at their lessons.
Line 387. They need to critically look at the activities that they give to the learners and see the opportunity of teaching at that particular point in time.
Line 388. So ummmh we've been using the model by Fritz of number sense.
Line 389. I also try and assist them in building their conceptual knowledge of using the number sense, so that then they can be able to assist their learners in the classroom.
Line 390. **N:** Ok. So how do you guide in reflection after their lesson presentations.
Line 391. **MT3:** Ummmh, after the presentation what I normally do is we reflect on the lesson and there would be some few questions that I would ask.
Line 392. There is a template, which is very generic that we normally use. It becomes some sort of a habit. It becomes very easy to answer those questions.
Line 393. So I try to derive my own questions on what was happening in the classroom. You know like for example, I would ask them what led them to do this.
Line 394. What made them to think of this activity or the resources that they are using in the classroom?
Line 395. When they were teaching, what is it that they observed about the learners? Did they think that there was learning that took place?
Line 396. You know at the end of the day as opposed to just marking and signing the books of the learners.
Line 397. Do they reflect on the activities of the learner during that particular assessment at the end of the day?
Line 398. So that's what I've actually tried to drive them at and make sure that at the end of the day, there is teaching and learning that takes place.
Line 399. **N:** So with that do you think students find it difficult or easy to reflect on their PCK?
Line 400. **MT3:** It's very difficult for them to reflect honestly so or objectively so because at this point in time because they are still students they are more orientated on marks.
Line 401. All that they want to see is that 75% but they don't want to know what, what's the word? Nali igama liyabaleka (This word is disappearing from me) laughs…
Line 402. **N:** What led to?
Line 403. **MT3:** Yes, what led to the 75% basically? So they would ummmh they want you to basically tell them about the good things that they have done but not the bad.
Line 404. You know when you start telling them about the bad things, some of them they feel withdrawn and they don't take criticism positively so you know.
Line 405. So but that's how we learn. You have to tell them that this is where you went wrong and this is how you can improve going forward.
Line 406. Some are able to take it but most of them are really struggling to take the criticism.
Line 407. **N:** Then lastly is there anything you would like to share regarding maths teaching or mentoring? From the teacher's perspective, what do you think needs to happen?
Line 408. **MT3**: I think there should be more interaction between the teachers and the students.
Line 409. The mentor and the student, with regards to the planning and execution of the lesson in the classroom.

Line 410. You find that most cases a mentor you walk in the morning and you start teaching without explaining clearly to the students what is it you will be teaching about and what are your expectations and so forth.
Line 411. So if we can have that collaborative type of mentoring.
Line 412. Where in the morning you can start by declaring your intentions for your lessons, your needs and your expectations.
Line 413. Also try to clarify the methods that you will be using that they can then be able to see the type of method.
Line 414. This is why she is doing one, two three.
Line 415. So collaborative mentoring is key so that students can be able to see exactly what is happening because if you don't explain or tell them exactly explanations.
Line 416. They become very bored in the classroom and they don't know what it is that they need to look for.
Line 417. At the end of the day if you just walk in as a student and somebody says observe and you not sure what it is you need to look for.
Line 418. But if somebody explains to you and involves you, then it becomes very easy for one to ask questions at the end of the day as well.
Line 419. **N:** Thank you.
Line 420. **MT3**: Alright.

ADDENDUM 3: Interview codes

Focus group 1

FG1/S1/PG 128/L3 code: Content knowledge	FG1/S1/PG128/L4 code: Know maths content
FG1/S1/PG 128/L5 code: Teaching methods	FG1/S1/PG 128/L6 code: Small talk
FG1/S2/PG 128/L 7& 8 code: Learning styles and emphasis on auditory style	FG1/S2/PG 128/L10-11: Concrete materials as examples
FG/S3/PG 128/L12 code: Learning styles	FG1/S3/PG 128/L13 code: Prior knowledge
FG1/S3/PG 128/L14 code: Making connections of prior & new knowledge	FG1/S4/PG 128/L16 code: Mathematical content knowledge
FG1/S4/PG 128/L16 code: CK comes before anything else.	

FG1/S4/PG 128/L17 code: Content knowledge	FG1/S4/PG 128/L20 code: Prior knowledge important for teaching
FG1/S2/PG 128/L26 code: Maths stages, references to Piaget's theory	FG1/S2/PG 128/L29 code: Using real life objects and examples to explain
FG1/PG2/S2/L30-31 code: Use of physical objects	FG1/S2/PG 128/L32-33 code: Fading concrete examples to abstract thinking
FG1/S2/PG 128/L34 code: Maths representations to show understanding	FG1/S5/PG 128/L 39 code: Learning from observations in the practicum

FG1/S5/PG 128/L 42 code: Using tactile/sensory methods for activities.	FG1/S5/PG 128/L 41 code: Rote activities
FG1/S5/PG 129/L 46 code: Teaching aids to avoid frustrated learners.	FG1/S5/PG 128/L 44 code: Using maths apparatus for teaching.
FG1/S1/PG 129/L 50-51 code: Discussions between teachers and learners important.	FG1/S5/PG 129/L 49 code: Emphasizes importance of using resources.

FG1/S1/PG 129/L 53-54 code: Learners participating through discussions	FG1/S1/PG 129/L 55 code: Q/A method important for learners for understanding.
FG1/S2/PG 129/L 56 code: Learning from observations of teaching at WIL.	FG1/S2/PG 129/L 58 code: Ability groups as a differentiation technique.
FG1/S2/PG 129/L 60 code: Teacher working with weaker learners.	FG1/S2/PG 129/L 61-62 code: Being patient and weaker learner benefit from repetition.
FG1/S2/PG 129/L 63-64 code: Reflecting in action and adapting teaching methods.	FG1/S2/PG 129/L 66-67 code: Using peer teaching. Strong learners helping weaker learners.

FG1/S5/PG 129/L 68-69 code: Emphasizes on the importance of peer teaching.	FG1/S1/PG 129/L74-75 code: Mentor teachers sticking o what they know
FG1/S1/PG 129/L 76-77 code: Mentor teachers encourage using similar methods and resources to theirs.	FG1/S1/PG 129/L 78 code: Students feel restricted in how they can teach
FG1/S1 & S3/PG 129/L 82-83 code: Emphasizing that they feel restricted at Funda.	FG1/S1/PG 129/L 85 code: Agrees with peers about feeling restricted.

FG1/S4/PG 129/L 88 code: Mentor teachers wanting them to teach in a certain way.	FG1/S4/PG 129/L 90-91 code: Feels that the mentor teachers will criticize their own method.
FG1/S3/PG 129/L 99 code: Mentor sessions bring clarity and set expectations	FG1/S3/PG 130/L 100 code: Clarity during mentoring.

FG1/S3/PG 130/L102 code: Feeling guided and learning something from the sessions.	FG1/S3/PG 130/L103 code: Sees different mentors as important.
FG1/S6/PG 130/L104 code: Knowing learner's ability levels.	FG1/S6/PG 130/L106 code: Range of vocabulary used progresses per grade.

FG1/S6/PG 130/L107 code: Learners also learn new vocabulary as well.	FG1/S6/PG 130/L111 code: Sees progression as well.
FG1/S6/PG 130/L113 code: Highlights different mentoring experiences in various grades.	FG1/S6/PG 130/L115 code: Progression in the mathematics language used.

FG1/S4/PG 130/L 118 code: Sees mentoring experiences as similar in grade 1 and 2.	FG1/S4/PG 130/L 120 code: Sometimes confused at the mentor teacher's directive.
FG1/S2/PG 130/L 122 code: View that mentoring is helpful	FG1/S2/PG 130/L 123 code: Clarifies the topic and some direction for the lesson planning.
FG1/S2/PG 130/L 124 code: In actual lesson, advice given can contradict what they are learning.	FG1/PG 130/All students/L 125 code: Students agree with the contradiction.

FG1/S3/PG 130/L 130 code: Mentors advice can differ to what they learn at the university.	FG1/S2/PG 130/L 132 code: Confusion about how teaching school seems separated from the university.
FG1/S2/PG 130/L 134-135 code: Students feel confused from unclear expectations and loose marks.	FG1/S2/PG 130/L 136 code: They reflect and often need to change things after.
FG1/S2/PG 130/L 138- 139 code: Emphasis that their CK is more based on what they learn at the university.	FG1/S3/PG 130/L 142 code: Students told what to put in a lesson.

FG1/S3/PG 130/L 143 code: Mentor teacher contradicts themselves from planning to feedback phase.	FG1/S3/PG 131/L 144 code: Mentors sometimes contradicts themselves
FG1/S6/PG 131/L 146 code: Teaching maths concepts such as division.	FG1/S6/PG 131/L 147 - 149 code: Feeling confused with maths vocabulary

FG1/S6/PG 131/L 150 -151 code: Students feeling confused by the mentor teacher's guidance.	FG1/S4/PG 131/L 155 code: Emphasize for mentoring sessions to be clear.

FG1/S4/PG 131/L 156 -157 code: Mentor teacher should not contradict themselves.	FG1/S4/PG 131/L 156 -157 code: Mentor teacher should not contradict themselves.
FG1/S4/PG 131/L 159 code: Content knowledge is important	FG1/S4/PG 131/L 160 code: Misunderstanding in how the teacher explained to learners.
FG1/S4/PG 131/L 162 -163 code: Students researching on CK topics they are not sure about.	FG1/S4/PG 131/L 164 code: Mentors teacher CK might have been incorrect.
FG1/S4/PG 131/L 166 code: The importance of CK before teaching a lesson.	FG1/S4/PG 131/L 168 code: Mentors also researching on the topics they teach. Instead of dictating how to teach.

FG1/S4/PG 131/L 169 - 170 code: Strong sense of having prior knowledge about what should be taught in a maths class.	FG1/S3/PG 131/L 171 code: Student feels that they are to include all learners in a lesson but mentor teacher does not always do it.
FG1/S3/PG 131/L 173 code: Some learners are not excited in the maths classroom.	FG1/S3/PG 131/L 171 code: Mentors not including all the learners in the lesson
FG1/PG 131/ All students/L 177 – 178 code: All students agree that sometimes learners are not all included in lessons	FG1/PG 131/S1,2, 3 & 5/L 180 code: What is expected is not always what is modelled.

FG1/S3/PG 131/L 183 code: Mentor teachers speak in one voice during mentoring session.	FG1/S3/PG 181/L 184 code: Sometimes information is left out in the sessions and said in the individual classes.

FG1/S3/PG 131/L 187 code: Contradictions in what students should expose learners to.	FG1/S2/PG 131/L 189 code: Number of practicum cycles a constraint to mentoring.
FG1/S2/PG 132/L 190 code: Different mentors have different views.	FG1/S2/PG 132/L 191 code: mentor's expectations and what he says during mentoring sessions is consistent.

Focus Group 2

FG2/S6/PG 132/L195 code: Learner's prior knowledge	FG2/S6/PG 132/L196 code: Basic prior knowledge such as counting
FG2/S7/PG 132/L198 code: Understand maths content and accommodate learners.	FG2/S8/PG 132/L 200 code: Know your strengths and weaknesses
FG2/S8/PG 132/L 201 code: Understand primary school maths content	FG2/S8/PG 132/L 206 code: Student acknowledges his strengths

FG2/S8/PG 132/L 207 code: Aesthetically pleasing and big teaching aids	FG2/S8/PG 132/L 208 code: Incorporating technology in teaching aids
FG2/S8/PG 132/L 209 code: Children must be able to manipulate resources	FG2/S9/PG 132/L 211 code: Creativity in your methods
FG2/S9/PG 132/L 213 code: Including your strengths into your method.	FG2/S10/PG 132/L 216 code: Explaining concepts is important
FG2/S10/PG 132/L 217 code: Explaining is important but does not guarantee learner's understanding	FG2/S9/PG 132/L 218 code: Physically using concrete examples before worksheets.

FG2/S10/PG 133/L 220 code: Q/A as important for discussions between teacher and learners	FG2/S11/PG 133/L 222 code: Using methods which capture and engage learners e.g. story
FG2/S11/PG 133/L 223 code: Using a story about place value.	FG2/S11/PG 133/L 224 code: Assumes that learners know rounding off

FG2/S8/PG 133/L 225 code: Using the learners to demonstrate as examples	FG2/S8/PG 133/L 226 code: Example of using concept of length and learners as examples
FG2/S10/PG 133/L 228 code: Importance of discussions and group work.	FG2/S10/PG 133/L 229 code: Group work is quicker

FG2/S10/PG 133/L 230 code: Asking them individually in groups	FG2/S7/PG 133/L 232 code: First observing the mentor teacher teach a concept
FG2/S7/PG 133/L 233 code: See what has been done then you should expand on it.	FG2/S10/PG 133/L 234 code: Students not using correct terminology for maths
FG2/S10/PG 133/L 235 code: Mentor teacher corrects and guides them	FG2/S10/PG 133/L 236 code: Example with fractions and using correct terms
FG2/S10/PG 133/L 237 code: Mentor emphasizes using correct terms	FG2/S10/PG 133/L 238 code: Acknowledges mentoring process.

FG2/S8/PG 133/L 239 code: Lesson plan procedure: Mentor provides feedback on planning	FG2/S8/PG 133/L 240 -241 code: Mentor guides in creative process of Lesson planning
FG2/S7/PG 134/L 243 code: Mentors encourage exploring new methods	FG2/S7/PG 134/L 244 code: Creativity in implementing teaching methods.
FG2/S7/PG 134/L 245 code: Mentor guides students in clarifying their teaching methods	FG2/S9/PG 134/L 246 code: Students given latitude to be creative

FG2/S8/PG 134/L 248 code: Confuses improvisation with reflection	FG2/S8/PG 134/L 249 code: Students can talk openly during reflection sessions
FG2/S8/PG 134/L 250 code: Some peers don’t participate in lesson planning	FG2/S8/PG 134/L 251 code: Focus on positive aspects during the reflection

FG2/S8/PG 134/L 252 code: Some students dominate the LP process	FG2/S8/PG 134/L 253 code: Mentor includes all students to respond during reflection
FG2/S12/PG 134/L 255 code: Mentor corrects student's PCK during reflection	FG2/S12/PG 134/L 256 code: conceptual understanding of concepts.

FG2/S12/PG 134/L 258 code: Conceptual understanding linked to PCK	FG2/S9/PG 134/L 259 code: Reflection not focused on learner's behaviour
FG2/S9/PG 134/L 260 code: Classroom management is student's responsibility for their lesson.	FG2/S9/PG 134/L 261 code: Mentor focuses on how you taught & what can improve
FG2/S8/PG 134/L 263 code: Learnt about teaching maths at Funda	FG2/S8/PG 134/L 264 code: Learnt how to represent numbers for learners.
FG2/S8/PG 134/L 265 code: Notation of numbers important	FG2/S7/PG 134/ L 266 code: Mentors have shared understanding of what should be done

FG2/S10/PG 135/L 269 code: Mentoring at teaching school helps them teach at WIL schools	FG2/S10/PG 135/ L 270 code: Developed confidence
FG2/S8/PG 135/ L 271 code: Used a method learnt at Funda to teach at WIL school	FG2/S8/PG 135/ L 272 code: Good responses from WIL teachers
FG2/S9/PG 135/ L 274 code: Good quality of lesson plans from WIL	FG2/S9/PG 135/ L 275 code: Teaching school as a model school for teaching.
FG2/S9/PG 135/ L 276 code: Learnt a lot about teaching from the teaching school	FG2/S9/PG 135/ L 278 code: Student has become confident at teaching

Individual interview 1 (Pilot interview)

II1/MT1/PG 135/L 283 code: CK for maths teaching	II1/MT1/PG 135/L 284 code: Pedagogy important
II1/MT1/PG 135/L 285 code: Know current methods of teaching	II1/MT1/PG 135/L 286 code: Relevant teaching methods
II1/MT1/PG 135/L 288 code: Involve all learners in the lessons	II1/MT1/PG 135/L 289 code: Participation and learner centred
II1/MT1/PG 135/L 290 code: Applying knowledge	II1/MT1/PG 135/L 291 code: Using teaching aids
II1/MT1/PG 135/L 292 code: Understand the sequencing of concepts	II1/MT1/PG 135/L 293 code: Teaching aids important

II1/MT1/PG 135/L 294 code: Teaching aids important for learners.	II1/MT1/PG 135/L 295 code: Teacher can refute/edify learner's responses
II1/MT1/PG 135/L 296 code: Using multimedia and what is available in the environment	II1/MT1/PG 136/L 299 code: Use mentoring rubric. Discuss observations, likes & dislikes
II1/MT1/PG 136/L 300 code: Mentor encourages to talk about positive aspects	II1/MT1/PG 136/L 301 code: Students learning from mistakes
II1/MT1/PG 136/L 302 code: Discuss planning, the lesson during mentoring	II1/MT1/PG 136/L 303 code: Also group involvement & how learners understood

II1/MT1/PG 136/L 304 code: Classroom management & teacher identity	II1/MT1/PG 136/L 305 code: Reflection on action to improve PCK
II1/MT1/PG 136/L 306 code: Reflection	II1/MT1/PG 136/L 307 code: Not focusing on the negative
II1/MT1/PG 136/L 308 code: Mentor should give critical but encouraging feedback	II1/MT1/PG 136/L 311 code: Reflect on teaching methods
II1/MT1/PG 136/L 312 code: Reflect on how the lesson was implemented	II1/MT1/PG 136/L 313 code: Awareness of reflection in action

II1/MT1/PG 136/L 314 code: Classroom management, teaching concepts & methods	II1/MT1/PG 136/L 316 code: Students applying their knowledge
II1/MT1/PG 136/L 317 code: Practice what they lectured through lessons	II1/MT1/PG 136/L 319 code: Practice at Funda teaching smaller groups
II1/MT1/PG 136/L 320 code: Then they can teach bigger groups	II1/MT1/PG 136/L 321 code: Importance of balance between theory & practice
II1/MT1/PG 136/L 322 code: Students should teach smaller groups throughout	II1/MT1/PG 136/L 323 code: Small group teaching method could be effective

II1/MT1/PG 137/L 324 code: Practice teaching in smaller groups first	II1/MT1/PG 137/L 325 code: Opportunity to teach at Funda for all students
II1/MT1/PG 137/L 326 code: Importance of reflection	

Individual interview 2

II2/MT2/PG 137/L 331 code: Knowledge of the curriculum	II2/MT2/PG 137/L 332 code: Effective pedagogies
II2/MT2/PG 137/L 333 code: Know learner's prior knowledge	II2/MT2/PG 137/L 334 code: CK is important

II2/MT2/PG 137/L 337 code: Using interactive teaching methods	II2/MT2/PG 137/L 340 code: Foster learner participation
II2/MT2/PG 137/L 341 code: Using different methods for different concept	II2/MT2/PG 137/L 342 code: Guiding students to use particular methods
II2/MT2/PG 137/L 344 code: Example of group work as a method	II2/MT2/PG 137/L 345 code: Mentoring: Get student's response about lesson

II2/MT2/PG 137/L 346 code: Student's identifying flaws and strengths	II2/MT2/PG 137/L 348 code: Reflect and methods and link to objectives
II2/MT2/PG 137/L 349 code: Students focus on what did not go well.	II2/MT2/PG 137/L 350 code: Reflecting on teaching methods
II2/MT2/PG 138/L 352 code: Students should reflect on their actions	II2/MT2/PG 138/L 353 code: Using a variety of teaching methods

II2/MT2/PG 138/L 354 code: Student's identifying relevant teaching methods	II2/MT2/PG 138/L 355 code: Curriculum knowledge
II2/MT2/PG 138/L 356 code: Important to consider learner's level.	II2/MT2/PG 138/L 358 code: Knowing learner's ability levels.

Individual interview 3

II3/MT3/PG 138/L 361 code: CK, PK develops through practice teaching	II3/MT3/PG 138/L 362 code: Knowing about maths cognition
II3/MT3/PG 138/L 363 code: Number sense important	II3/MT3/PG 138/L 364 code: Students struggle with developing number sense
II3/MT3/PG 138/L 365 code: Students don't explain meaning of operational signs	II3/MT3/PG 138/L 366 code: Operational signs more abstract in grade 3 e.g. ÷
II3/MT3/PG 138/L 366 code: Not explaining operational signs confuses learners	II3/MT3/PG 138/L 366 code: Students lack maths vocabulary

II3/MT3/PG 138/L 370 code: Students methods are procedural	II3/MT3/PG 138/L 371 code: Students teach for the sake of it
II3/MT3/PG 138/L 372 code: Students favour Q/A method and explaining	II3/MT3/PG 138/L 373 code: 4^{th} year student's use games for maths teaching
II3/MT3/PG 138/L 374 code: Games don't develop CPU if planned poorly	II3/MT3/PG 138/L 375 code: Student's don't teach for conceptual understanding

II3/MT3/PG 138/L 378 code: Focus on procedural knowledge	II3/MT3/PG 138/L 380 code: Mentoring can enhance conceptual understanding
II3/MT3/PG 139/L 381 code: Students focus on procedures	II3/MT3/PG 139/L 383- 384 code: Maths teaching should develop conceptual understanding
II3/MT3/PG 139/L 385 code: Assisting learners develop number sense	II3/MT3/PG 139/L 387 code: Students to critically reflect on lessons
II3/MT3/PG 139/L 388 code: Reflect on maths tasks	II3/MT3/PG 139/L 389 code: Refers to theoretical model for mentoring

II3/MT3/PG 139/L 390 code: Mentor develops student's CPU for students to help learners	II3/MT3/PG 139/L 392 code: Reflect on the lessons
II3/MT3/PG 139/L 393 code: Mentoring questions in rubric are very easy	II3/MT3/PG 139/L 394 code: Mentor derives own reflection question
II3/MT3/PG 139/L 396 code: Mentor asks questions about their PCK	II3/MT3/PG 139/L 399 code: Mentor's responsibility that teaching happens
II3/MT3/PG 139/L 401 code: Students are mark oriented. Lack in objective reflection	II3/MT3/PG 139/L 404 code: Students only want positive feedback
II3/MT3/PG 139/L 405 code: Students struggle with critical feedback	II3/MT3/PG 139/L 406 code: Mentor providing positive & critical feedback
II3/MT3/PG 139/L 409 code: More interaction between mentor & students	II3/MT3/PG 140/L 410 code: Interaction in planning & execution of lessons
II3/MT3/PG 140/L 411 code: Mentor needs to explain expectations	II3/MT3/PG 140/L 412 code:
II3/MT3/PG 140/L 412 code: Collaborative mentoring	II3/MT3/PG 140L 413 code: Mentor should declare intentions, needs & expectations
II3/MT3/PG 140/L 414 code: Mentor must clarify teaching methods	II3/MT3/PG 140/L 416 code: Collaborative mentoring helps students understand the 'why'and 'how'

II3/MT3/PG 140/L 417 code: Students become bored when they’re not engaged	II3/MT3/PG 140/L 419 code: Involving students makes them participate more